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This report is part of the National Network for Environmental Management Studies (NNEMS) conducted under the auspices of the Office of Cooperative Environmental Management-U. S. Environmental Protection Agency (EPA). This study assists air quality planners at the regional, state, and federal level in the use of Jobs/Housing (J/HB) balance Indicators. It examines the J/HB indicator as a tool in developing measures to reduce commuting distances by better placement of jobs and housing. An area is said to have a balance of jobs and housing if housing is available to workers within a reasonable commuting distance and at a price affordable to those workers. Reducing the distance, time and number of commuting trips can decrease mobile-source air pollution and therefor improve air quality.

Two types of Jobs/Housing balance indicators, the "ratio" and the "range" are defined and critiqued. The ratio of jobs and housing (the J/H ratio) is defined as the ratio of job-generated households to housing units in an area within a reasonable commuting distance. The J/H range is the comparison of the quantity of housing units demanded at an affordable price to the quantity of housing units available at a price level. The J/H range is the balance indicator recommended in this study.

This study offers a methodology for planners in applying the J/H range to the development of sites that are rich in jobs but poor in housing. The study also presents examples of land use control measures which are of use to regional and local government planners.

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USING JOBS/HOUSING BALANCE INDICATORS FOR AIR POLLUTION CONTROLS

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PREPARED FOR THE ENVIRONMENTAL PROTECTION AGENCY
REGION IX, AIR AND TOXICS BRANCH

MAY 10, 1989

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USING JOBS/HOUSING BALANCE INDICATORS FOR AIR POLLUTION CONTROLS

EXECUTIVE SUMMARY

This study assists air quality planners at the regional, state and federal level who are seeking to use the idea of a jobs/housing balance (J/HB). This study looks at indicators of balance as a tool in developing measures to reduce commutes through better placement of jobs and housing. An area is said to have a balance of jobs and housing if housing is available to workers at a near commute distance and at a price affordable to the workers' households. Reducing commute distances, times or trips can decrease mobile source air pollution to improve air quality attainment.

DEFINITION OF J/H INDICATORS

This study defines and critiques two indicators of the jobs/housing balance: the "ratio" and the "range". The ratio of jobs and housing -- or the "J/H ratio" -- in its best form, is the ratio of households generated by local job sites compared to the number of housing units in the locality. The J/H ratio is incorrectly used when it is applied to just cities or counties. Commutesheds or transportation corridors around a city or project are the relevant sub-regional areas in which a balance should be sought.

The "J/H range" is the indicator of balance recommended by this study. The "J/H range" is the comparison of the quantity of housing units demanded at an affordable price to the quantity of housing units available at that price level. The J/H range compares prices affordable to households at their income, with the availability of housing units. The J/H range includes household income and housing price realities in the analysis of residential location decisions in job and housing markets.

To be correctly used, the range should indicate balances within appropriate commute distances in a sub-regional area, or in the market around a new development site. Regional air pollution control districts (APCDs) could research local conditions and use mobile source trip models to designate appropriate subregional "commutesheds".

The ideal J/H range would show a match-up of household affordability and housing availability for each housing price. Each percentile of household income should be able to find a supply of housing at an affordable price.

PROBLEMS WITH INDICATORS

Neither the ratio nor the range adequately deal with the many substitutes for commute distance which a consumer/worker can make. As examples, the consumer can choose to overpay for housing, or overcrowd, or receive more luxuries (such as large lots) in more distant housing. Economic models of housing markets, such as hedonic price theory, consumer choice theories and push-pull gravity models are complex and not yet useful for policy making in this

area. The models include multiple regressions of the structural and site attributes, neighborhood amenities and commute distances. They model the jobs and housing markets and consumer trade-offs, but only provide hints of the effects of policy actions.

APPLICATIONS: CREATING LAND USE CONTROL MEASURES

This study offers a methodology for applying the J/H range to development site approval for an area rich in jobs but poor in housing. The current sub-regional J/H range should be measured, then used to indicate the allowable mix of housing and job creation in the new development. A strong requirement on developers could be: to invert the current sub-regional J/H range fractions to set the goals for balance at the new site for each household income level. The developer could still choose either the total number of new jobs or housing at the site, but future housing should be distributed according to current household income distribution. This methodology forces a net improvement on current regional imbalances, while maximizing the developer's ability to develop higher income jobs and housing.

This study also presents an example of a land use control measure of use to regions and local governments. The measure is appropriate for a jobs-rich, housing-poor sub-region. The measure promotes higher density residential zoning near mass transit nodes. Regional APCDs, in concert with regional agencies, could be responsible for setting goals for greater density housing development.

Local jurisdictions could be asked to reach "housing density bubble" standards through General Plan and zoning policies. As an example, the "pedestrian pocket" concept is described. The pedestrian pocket avoids heavily polluting cold-auto-starts through walking and mass transit commutes. Local policies for bubble areas near transit nodes could include higher density zoning, facilitating conditional land uses, inclusionary zoning such as percentage requirements for low income housing, and density bonuses for low income housing commitments. Current housing subsidies could also be redirected to target bubble areas at little additional cost.

As regional agencies and states seek measures for State Improvement Plans, they will increasingly attempt land use control measures which use the J/HB concept. The success of such measures are hard to predict, since they are long term and consumers may not choose to live in the housing with the shortest commute distance. J/HB based measures also must avoid infringement on local zoning control under current California Sher Bill and current federal Clean Air Act amendments.

USING JOBS/HOUSING BALANCE INDICATORS FOR AIR POLLUTION CONTROLS

CONTENTS

I.	**INTRODUCTION**		1
	1.	THE PROBLEM: APPLYING "THE JOBS/HOUSING BALANCE" CONCEPT	1
	2.	BACKGROUND ON PREVIOUS J/HB STUDIES	2
II.	**INDICATORS OF THE JOBS/HOUSING BALANCE**		5
	1.	THE J/H RATIO -- DEFINITION	5
	2.	THE J/H RATIO -- CRITIQUE	6
	3.	THE J/H RANGE -- DEFINITION	8
	4.	THE J/H RANGE -- ADVANTAGES AND DISADVANTAGES	14
	5.	A SUB-REGION'S ACTUAL J/H RANGE	15
	6.	POLICY CONCLUSIONS FROM CONSUMER CHOICE MODELS	19
III.	**APPLYING THE INDICATORS TO CONTROL MEASURES**		20
	1.	CRITERIA FOR MEASURABLE AND ENFORCEABLE MEASURES	20
	2.	ENFORCEMENT MECHANISMS	21
	3.	HOW TO SET GOALS WITH THE J/H RANGE	22
IV.	**AN EXAMPLE OF A J/HB BASED LAND USE CONTROL MEASURE: HIGHER DENSITY RESIDENTIAL ZONING NEAR TRANSIT NODES**		25
V.	**SELECTED J/HB BASED CONTROL MEASURES**		31
	1.	ZONING MEASURES	31
	2.	HOUSING PRODUCTION MEASURES	32
	3.	JOB AND INDUSTRIAL PLACEMENT MEASURES	33
	4.	TRIP REDUCTION AND DISTANCE IMPEDANCE MEASURES	33
VI.	**PREDICTIONS OF EFFECTS: ON REGIONAL ORGANIZATION AND GREENBELTS**		34

CONTENTS OF APPENDICES AND FIGURES

		PAGE
APPENDIX A		
	MODELS OF CONSUMER CHOICE IN RESIDENTIAL LOCATION	35
A.1.	ABSTRACT	35
A.2.	HEDONIC PRICE MODELS OF LOCATIONAL CHOICE	35
A.3.	APPLICATION OF ECONOMIC MODELLING	38
A.4.	LOGIT AND PROBIT MODELS OF RESIDENTIAL CHOICE: NEW HOPE	41
A.5.	CERVERO'S PUSH-PULL GRAVITY MODEL	42
A.6	THE ABAG APPROACH TO MEASURING JOBS/HOUSING BALANCE	44
APPENDIX B		
	WHICH AREAS SHOULD APPLY J/HB BASED MEASURES?	45
B.1.	LAND USE CONTROL MEASURES	45
B.2	COSTS AND BENEFITS OF LAND USE CONTROL MEASURES	47
B.3	J/HB BASED MEASURES AND NON-ATTAINMENT AREAS	48
APPENDIX C		
	BIBLIOGRAPHY OF LAND USE CONTROL MEASURE STUDIES	50
FIGURE 1	AFFORDABILITY CURVE -- J/H RANGE	9
FIGURE 2	AVAILABILITY CURVE -- J/H RANGE	10
FIGURE 3	AFFORDABILITY/AVAILABILITY GAP	11
FIGURE 4	AFFORDABILITY/AVAILABILITY GAP	13
FIGURE 5	CONTRA COSTA AFFORDABILITY CURVE	17
FIGURE 6	NEW HOME PRICES 1982-1987	17
FIGURE 7	RESALE HOME PRICES 1987	18
FIGURE 8	AFFORDABILITY/AVAILABILITY GAP	18
FIGURE 9	RENT GRADIENT	37
FIGURE 10	RENT GRADIENT WITH GREENBELT	37
TABLE 1	MATRIX FOR GOAL-SETTING WITH THE J/H RANGE	24

USING JOBS/HOUSING BALANCE INDICATORS FOR AIR POLLUTION CONTROLS

by Bruce Lee Livingston

MAY 10, 1989

I. INTRODUCTION

I.1. THE PROBLEM: APPLYING THE "JOBS/HOUSING BALANCE" CONCEPT

Planners, environmentalists and policy makers have long been intrigued by the idea of achieving a better balance of job location and housing location. Such a balance is desirable to reduce commute distances, reduce transportation-caused air pollution, reduce gasoline usage, concentrate urban sprawl, and preserve open space. Regions with degraded air quality are beginning to look at the spacial dispersion of housing and jobs in commute distances around a region as a contributing factor to mobile source air pollution.

An area is said to have a balance of jobs and housing if housing is available to workers at a near commute distance and at a price affordable to the workers' households. An imbalance occurs if too few housing units are available at the right price to workers, who are then forced to commute longer distances to their workplace.

The California Department of Housing and Community Development states that:

> A jobs/housing balance occurs if people live in housing that is affordable at the wages they earn, and travel minimum distances to their jobs and the services they use. In a well planned community or region, attaining a jobs/housing balance primarily involves: relating projected household costs to projected household incomes; ensuring an adequate supply of the affordable housing; and making sure there are adequate public and private services needed by the population. In a "balanced community" the housing units are also available for occupancy at the same time the new jobs are created. Measures to assure the affordability of the housing over time will preserve this balance. All these factors should be present within a commuting radius that effectively uses public and private transportation resources and preserves air quality.[1]

The above definitions of J/HB are comprehensive and provide a general description. However, they are not adequate for making policy. This study develops quantitative indicators of the J/HB in such a way as to be useful for air quality planners.

This study usually refers to the "jobs/housing balance" and not the "jobs/housing **imbalance**", with the understanding that the terms are equivalent. A commute is caused by the imbalance of the job location and housing location. It is the degree of commute distance and time which worries air pollution, energy and land use policy makers. A sub-region or

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[1] California Department of Housing and Community Development, 101 Steps to Better Housing, draft, September 1982.

"commuteshed" constitutes a reasonably pollution minimizing commute area. It is imbalanced when too many people commute in or out, because either job opportunities or housing opportunities do not exist in the sub-region.

The object of this study is to describe and critique indicators of the J/HB. Air quality planners need indicators which use available data to quantify the extent of imbalance. The indicators should also be useful in setting goals for local jurisdictions to reach.

This study will focus on four problematic aspects of the J/HB concept which make it difficult to quantify the J/HB through indicators:

- Households have different incomes which limit their ability to buy, rent or lease housing near their place of work. Housing prices also vary across a wide range. Analysis needs to include projections on job growth, salaries, household incomes and housing prices.
- It is difficult to adequately define a suitable sub-region or commuteshed. Nearness to work is not well defined by simply assuming that a commute is near if it is within the expedient jurisdiction of the planning agency. Sub-regions and regional imbalances are also important. Because cold-starts of engines contribute greatly to air poliution, walking distance commutes are preferable.
- A J/HB indicator should look at projected new households and new housing units for the site, as well as at the current sub-regional or market J/HB.
- Residential location decisions are part of a large number of decisions on housing attributes; attributes include structural and size attributes and locational amenities. Consumers are willing to trade-off longer commute distances for other amenities.

Even if a measurable J/HB indicator is developed, there is still the political and administrative difficulty of implementation. Will the indicators be targets for local communities to reach or thresholds to avoid? How will measures which use the indicators be enforced? Will the cities, counties or APCDs enforce the policies? What will be the role of the Environmental Protection Agency (EPA), the statewide Air Resources Board (ARB), and regional air pollution control, planning and transportation agencies? To what extent should local jurisdictions still control zoning, housing subsidy disbursement, transportation planning and economic development?

I.2 BACKGROUND ON PREVIOUS J/HB STUDIES

Achieving a better balance of jobs and housing is like the weather; it is often talked about as a potential land use control measure, but no one ever does anything about it. This section introduces recent efforts by APCDs, planning authorities, and academic researchers to define the J/HB in useful ways.

Transportation control measures which use land use and zoning controls or incentives are more properly called "land use control measures". Policies which use indicators of the balance (or imbalance) of jobs and housing are called "jobs/housing based land use control measures" in this report.

In general, land use controls reallocate property rights -- rights to develop, trade and use property. Land use controls are almost exclusively within the power of local governments, except for clear areas of eminent domain by state and federal agencies. Land use control measures are discussed more thoroughly in **APPENDIX B**.

Some of the recent work on J/HB includes:

- **The South Coast Air Quality Management Plan.**
  The 1988 Revision South Coast Air Quality Management Plan goes further than any previous regional plans in using a J/H ratio in regional air quality planning. The South Coast Growth Management Plan develops ratios of jobs to housing for each city and each sub-region. Projections of future imbalances, under current policies, are developed. Each city is asked to reach a better balance of jobs and housing within the city through methods of its own discretion. Projects with regional impacts will have to respond first, to the impact on the city's J/HB as measured by the ratio, and second, to impacts on the sub-region as measured by the ratio. In effect, the J/H ratio is used as a statement of the city's imbalance. City's are given the goal of moving toward a balance within the city's boundary.

- **Southern California Association of Governments (SCAG) studies.**
  As background, the Southern California Association of Governments commissioned studies of possible land use and commercial location policies which cities could adopt. SCAG also compiled a survey and selection of J/HB related actions by California jurisdictions.

- **Regional Air Quality Plans and Air Quality Elements.**
  Several regional air quality plans define traffic mitigation measures for new development. A movement is also underway to require air quality elements in General Plans, where such traffic mitigations could be required at the local level.

- **The Bay Area Air Quality Management Plan.**
  The Bay Area Air Quality Management Plan of 1982 lists land use measures in a separate section. The particular measures are left up to the discretion of the local jurisdictions. A follow-up study to the 1982 plan by the Association of Bay Area Governments develops a methodology for indicating the level of imbalance. The methodology goes beyond a simple ratio of jobs and housing. It identifies a range of household incomes for expected new workers in the Bay Area from 1985 to 1990. Then it estimates how many of the households will be "overpaying" for housing according to criteria put forth by the Department of Housing and Urban Development (HUD). This methodology is discussed in **APPENDIX A** in more detail. Unfortunately, this method does not directly use data on housing availability. The method leaves the housing side of the J/HB unclear, so it is not a good indicator of the J/HB.

- **Academic studies of land use and transportation policies.**
  Academic studies which relate land use and transportation provide background for J/HB based policies. Professor Elizabeth Deakin of the University of California at Berkeley has suggested greater integration of land use planning at the time when transportation decisions are made. Professor Robert Cervero, also at U.C. Berkeley, has used the push-pull gravity model to analyze factors that contribute to imbalances and longer commutes. His report is discussed in **APPENDIX A**. A number of articles by Cervero suggest land use and zoning decontrol mechanisms to improve J/HB.

- **Other reports and consulting studies.**
  A study by the consulting firm of Kreines and Kreines demonstrates a presentation method for including data on the J/HB in various staff reports, General Plan elements and environmental reviews. The Sacramento County Department of Planning studied the effects of new developments on commute distances and housing availability.

These and other studies of the J/HB are compiled in the bibliography in **APPENDIX C**.

II. INDICATORS OF THE JOBS/HOUSING BALANCE

The following sections describe and critique two methods of indicating the extent of imbalance of jobs and housing.

The "J/H ratio" is defined as the ratio of job-generated households to housing units in an area of reasonable commute distance. It is criticized for its lack of sensitivity to income levels and differential housing prices. It fails to define an appropriate market or "nearness" measurement when it simply uses the local jurisdiction boundaries.

The "J/H range" is the comparison of the quantity of housing units demanded at an affordable price to the quantity of housing units available at a price level. The J/H range is graphed and data on Contra Costa County is used to show the gap between household affordability and housing unit availability for a sub-regional commuteshed.

Both the ratio and the range fail to take into account the unpredictability of consumer behavior; housing consumers can trade-off the opportunity to live closer to work for any number of possible locational amenities and housing quality attributes. Nonetheless, the J/H range is recommended for use by regional planners because it incorporates household incomes, housing prices, and a correct definition of commuteshed or sub-regional area.

II.1. DEFINITION OF THE J/H RATIO

The J/H ratio has many interpretations. Sometimes planners assume that it is the simple ratio of jobs to housing in a commute area, region, county or city. Such a ratio would normally be greater than one, since most households have more than one full-time equivalent worker. It is confusing to think that a strange number, greater than one, is an indicator of balance. The simple ratio indicator does not take into account the variance in number of workers per household. The individual worker is not the sole concern in the market; it is the worker within the context of a household unit who chooses residential location, price and attributes.

A more useful ratio is to indicate the J/HB through the comparison of the number of households generated by local commerce and the number of housing units. This assumes that households are formed or in place before seeking the next housing unit. The number of households is determined exogenously by job growth in the region or job market and by the preference of workers for living together or creating families. Households (formed or imported exogenously by job growth) determine demand for housing.

For this reason, this study defines the "J/H ratio" indicator as **the ratio of the number of job-generated households divided by the number of housing units in the locality.** Such a

ratio should indeed equal one in a balanced community.[2] The number of households generated by local business should ideally equal the number of housing units in the locality.

The ratio described above is still unclear as to what defines an area that is suitably near to work.

The next section critiques the J/H ratio indicator of the J/HB.

II.2. THE J/H RATIO -- CRITIQUE

This section offers a broad critique of the J/H ratio of job-generated households to housing units. The problems are relevant to any attempt to develop an adequate indicator of the J/HB.

The range of incomes and housing prices

The J/H ratio is inadequate in that it ignores household income differences and the range and complexity of housing prices. A one to one ratio does not imply that incomes are matched with housing prices. However, unless such a match is assured, then commuting in and out of the area could always be a problem. Public policy needs to encourage a match of household incomes with housing prices in order to reduce imbalances which cause excessive commuting.

This problem is discussed extensively in the next sections on the J/H range. An adequate analysis needs projections on job growth, salary levels per job, household incomes, and housing prices. Then the relationship of supply and demand in the relevant commute area can be computed.

Defining nearness to work or relevant commute areas

The idea of being "near" the place of work is ill-defined. It is politically expedient to define the relevant "near" area as being the local jurisdiction which is being studied. However, it is the sub-regional commute area around new housing or commercial projects which is truly relevant. Housing and job markets are more relevant to locational, employment and commute decisions than jurisdictional areas.

This study uses the terms "commuteshed", "transportation corridor" and "sub-regional commute area" to refer loosely to a suitable distance around job sites for commutes. The distances and geographic boundaries of sub-regions need to be determined with technical knowledge of transportation infrastructure capacity, transit mode alternatives, peak-hour commute problems, and local meteorology.

Some jurisdictions are using six or eight mile driving distances as suitable distances to job sites.[3] However, cold auto starts and short automobile trips are almost as bad as long automobile commutes in causing mobile source pollution results. In most vehicles the first 30 seconds of use time contributes a disproportional amount of air pollution.

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[2] In simpler J/HB formulations, jobs are compared directly with housing measured by U.S. census data on the number of households. The census measurement of households (as a proxy for housing) should not be confused with estimates of households (as a proxy for jobs). Estimates of **job-generated households** are derived from current employment data, employment growth projections and workers-per-household estimates. Worker-per-household estimates can be obtained from the Census, but it is difficult to update because the size of households change with economic conditions, demographic shifts and taste.

[3] The Sacramento County General Plan uses street mileage to job sites to define acceptable commutesheds. In South Placer County, the SPPC Policy Plan requires that, "the home-to-work commute for all workers in the industrial core area need be no more than 6 miles for 60% of the workers, nor more than 8 miles for 80% of the workers, if they so choose." This is republished in the SCAG Job-Housing Survey (see **APPENDIX C**, bibliography).

Walking commutes to mass transit are therefore much preferable to drives to mass transit. Models which use census data need to compensate for use of mass transit and walking in those census tracts. Walking commutes and use of mass transit should count as more "near" than automotive drive commutes. Transit mode alternatives, voluntary travel time-saving devices such as ride-sharing, and effective, operative transportation control measures need to be accounted for in defining nearness-to-work.

The policy goal is to reduce air pollution through both reduction of cold starts and reduction of vehicle miles travelled. Policies will have to encourage adequate densities to support van-pooling and mass transit. (If policies promoted short drives they might discourage van-pooling and cause a net increase in vehicle miles travelled -- thus worsening air quality!) The most secure policies will encourage walk or bike distances to mass transit (at origination) or to work sites (at destination).

Finally, the assumption that workers first are employed, and then seek housing, may not always be correct. More adequate models would include situations (or at least the possibility) of settled renters or homeowners who then change jobs in order to remain at their current residence. An increasing complication is that multiple worker families may have to decide on an "in-between" area for their residence. Residential location decisions of families with more than two workers are extremely difficult to predict.

New households and housing units -- marginals

The J/HB indicator needs to look at the marginal household entering the rental or homebuying market; and the marginal job-seeker, not the only at the worker already working. The households and workers in place are not going to be immediately impacted by changes in land-use, zoning controls, growth controls, or housing subsidies. Households will be impacted when they choose to move or when they change job location. Households and workers in place are measured by current "journey-to-work" data. Current imbalances in the relevant market and the contribution of growth to future imbalances are the indicators which need to be examined.

The Association of Bay Area Governments, for example, correctly used projections of future household income derived from sub-regional growth projections. Planning agencies would do well to also predict future job growth.

In the time frame of a new site development the region's J/HB will not usually shift significantly. Therefore, the new site's projected balance can safely be compared to current balances without loss of much accuracy.

The complexity of housing residential decisions

Housing affordability near the place of work is complicated by the multiple, utility-maximizing decisions which consumers make in choosing a home. Affordability is ill-defined, since households can choose crowding, leaving the region, rent delays, high crime areas, or poor quality, among other attributes, as substitutes for cheaper housing at a greater distance.

Housing price itself is unclear because housing is not a normal standardized product. A house consists of a "bundle of goods" which must be valued by the consumer. The housing "bundle" includes structural attributes, quality attributes, size attributes, a commute distance value and locational amenities.

The utility-maximizing consumer and "bundle of goods" nature of housing are discussed further in **Section II.6. ("Policy Conclusions from Consumer Choice Theory")** and in **APPENDIX A**.

Housing consumers make complicated trade-offs among the bundle of goods and prices of housing. Policy results of land use controls can never be certain. Opportunities can be given for residential location, commercial job siting and transit modal choice. Without adequate models of consumer choice and housing pricing, the results of J/HB based measures remain difficult to predict.

The J/H ratio is a useful indicator for a quick look at a city's J/HB, but is subject to the many problems described above. The ratio can perhaps overcome the problems of defining relevant commute areas and projections of regional growth and site build-out. The J/H ratio can never adequately match the range of household incomes and housing prices. Neither can it deal with the complicated consumer trade-offs of housing attributes, neighborhood amenities, travel distance and modal choices.

II.3. THE J/H RANGE -- DEFINITION

The J/H range is the indicator of balance which is recommended by this study. The "J/H range" is the comparison of the quantity of housing units demanded at an affordable price to the quantity of housing units available at the same price level. The range compares prices for which households can afford (or are willing to pay), with the available supply of housing units at the right price. The J/H range thus includes household income and housing price realities in the analysis of residential location decisions in job and housing markets.

The ideal J/H range would show a match-up of household affordability and housing availability for each housing price. The J/H range, correctly used, should indicate balances within appropriate commute distances or times in a sub-regional area.

A range of household incomes is translated into a range of demand for affordable housing prices by a multiplicative factor which relates income to acceptable rents or possible homebuying prices. Such an affordability factor is usually a "rule of thumb", such as: "rental housing should cost only one-fourth or 30% of the renter's monthly income," or "A home purchase should not exceed 3.5 times your annual income." The Department of Housing and Urban Development (HUD) utilizes such rules to determine poverty levels and "overpayment" for housing. Using rules of thumb, the range of affordable housing prices can then be compared to data on the range of available housing prices.

It is helpful to graphically present the J/H range. The following three figures illustrate the range indicator. The **Figures 1, 2 & 3** show expected distributions of affordable housing demand and housing availability in an area which is jobs-rich and housing-poor.

The Affordability Curve:

Figure 1 graphs a cumulative frequency distribution of housing prices which are **affordable to households** in the commuteshed/subregion. It shows on the vertical axis the percentage of households who cannot afford housing above the price shown on the horizontal axis. If the households paid more they would be overpaying and if they paid less they would receive consumer surplus or less housing than they could afford.

The percentages can also be read as percentiles; for example, the households at the 75 percentile of housing affordability (or income) demand housing affordable to them at "x" price.

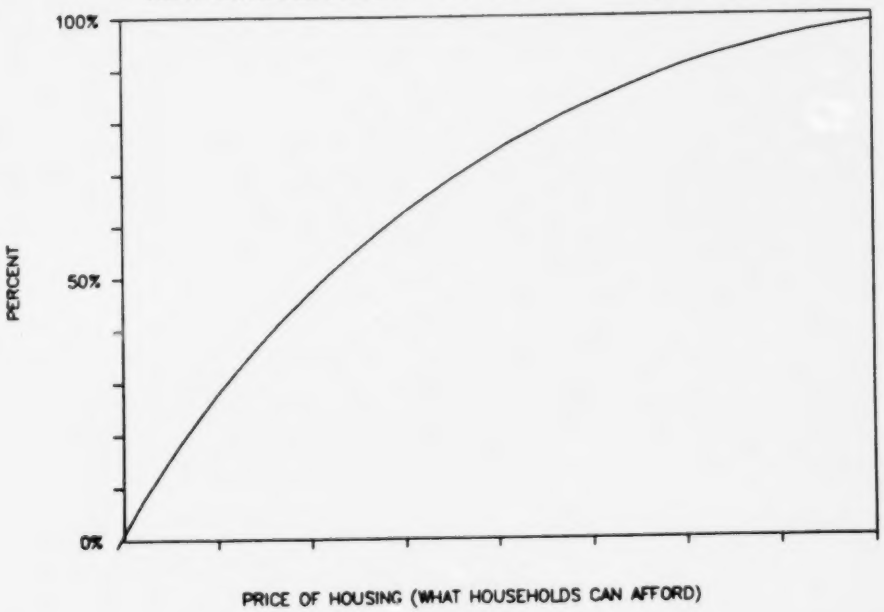
The graph depicts the demand for housing at a each price and implicitly shows the percentage of households which are at or below an income level at which they could afford that price. The curve therefore shows the household willingness to pay a price for housing in a near distance to work through the range of household incomes -- all other attributes of household and housing being equal. An important assumption is made: it is assumed that similar sized households prefer similar housing attributes. For example, all five person households of $50,000 a year income might be assumed to prefer a 3 bedroom, 2 bath, one acre house five miles from work at $175,000.

The curve can be called the **"affordability curve."**

The affordability curve has the same shape as a distribution of incomes curve because it is derived by multiplying income by a "rule of thumb" factor. The cumulative frequency distribution of incomes in the United States is normally a geometric curve, so the affordability curve is predicted to be a geometric curve as well. The affordability curve depicts the "jobs" side of the jobs/housing balance because jobs exogenously generate households and household incomes, and households generate a demand for affordable housing.

FIGURE 1

AFFORDABILITY CURVE -- J/H RANGE

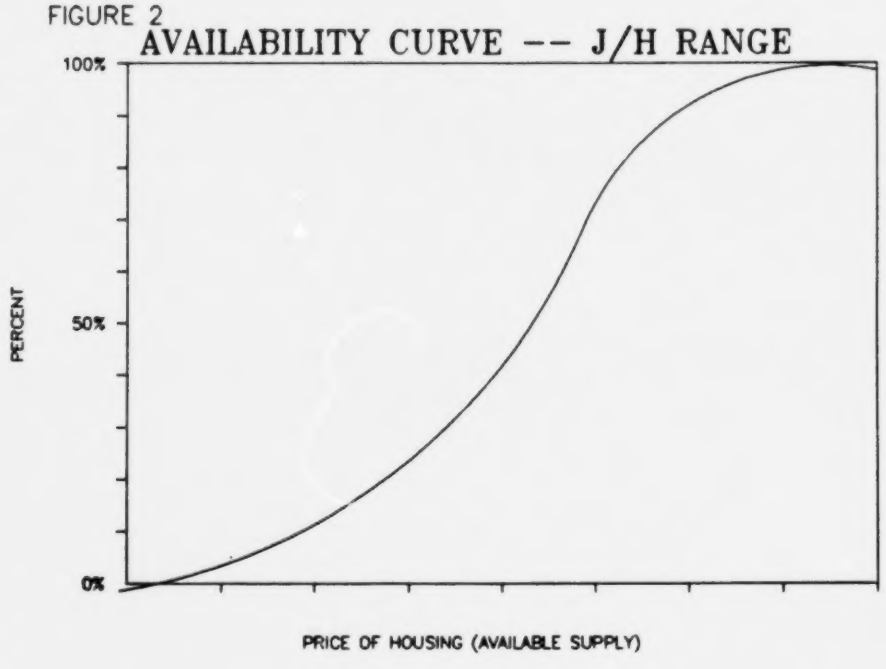


The Availability Curve:

Figure 2 graphs a cumulative frequency distribution of **housing units available** in the market across a range of prices. The graph shows the percentage of total units available on the market at each price. **Figure 2 depicts the expected distribution of available housing units.** The curve of **Figure 2** graphs the **"availability curve."** The availability curve is similar to a supply curve, except that housing is not a uniform commodity and households are not a single, rational consumer. An assumption is made that housing price reflects a uniform increase in the appropriate housing attributes which different size families require.

For many regions, sub-regions and cities the availability curve is hypothesized to be an "S" curve or logarithmic curve. This could be because: more upper income housing units are built than lower income units; many lower income units come from trickling down from the older higher priced units; and more lower income households than upper incomes tend to overpay for housing.

FIGURE 2



The Affordability/Availability Gap (jobs-rich, housing-poor subregion):

Figure 3 combines the two previous graphs. **The gap under the affordability curve and over the availability curve is an indicator of the imbalance of jobs and housing in the subregion at each price level. The imbalance can be called the "affordability/availability gap."** Housing advocates have called similar results the "affordable housing gap."[4]

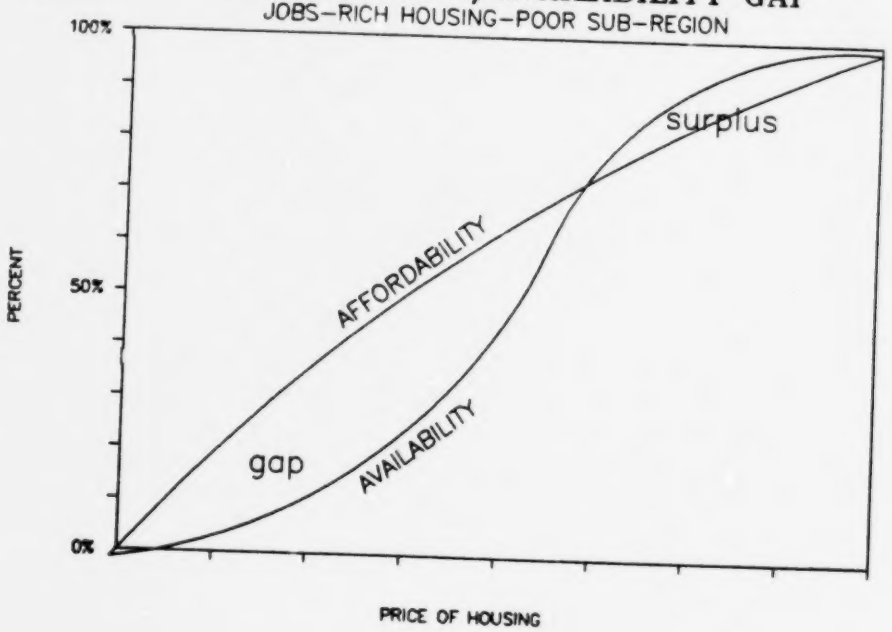
At the higher priced housing levels, the availability curve could cross over the affordability curve, indicating a surplus of housing for upper income households.

The affordability/availability gap can be read across (instead of up and down) to provide an economic interpretation of entry into the housing market. Consumers of higher incomes enter the market first by outbidding lower incomes. For example, consumer at the 90 percentile of income finds housing available to the left on the availability line at the 80 percentile of price, less than what he or she is willing to pay. A consumer at the 25 percentile of income on the affordability line finds housing to the right on the availability line at a higher price than is affordable. The consumer will choose to commute a longer distance or overpay for housing.

The affordability/availability gap, read across, is the gap between the price a household can afford for housing and the price which is available.

The hypothesis is illustrated in **Figure 3** that in jobs-rich areas the affordability/availability gap may be widest for moderate and low income households.

FIGURE 3 AFFORDABILITY/AVAILABILITY GAP



[4] See a report published by the Center on Budget and Policy Priorities, Robert Greenstein, director called "A Place to Call Home: The Crisis in Housing for the Poor," March, 1989. The report found an affordable housing gap for families of any size earning less than $10,000 a year, with 3.7 million fewer low-cost units available than are needed.

When the J/H range is plotted in this way it can point to policy and individual responses to the imbalance of jobs and housing. Responses to jobs-rich sub-regions should attempt to lower the affordability curve or shift it to right, or policy measures should raise the availability curve or shift it to the left.

The affordability curve can be shifted to the right by policy measures which include raising incomes, creating jobs, and moving jobs. Such interventions in commercial markets may be useful, but they are beyond the scope of this work.

The individual consumer shifts his or her affordability curve by lowering expectations of housing attributes or by raising income. The consumer often lowers expectations by substituting attributes in the housing "bundle of goods." For example, a consumer could decide that a dining room is not a necessity, thereby demanding less housing for the same price. Lowering of the affordability curve will bring more housing into the range of households shopping for homes or rentals. The attribute of "nearness to work" is very important. Consumers will look at more distant housing to find more affordable prices.

In order to shift the availability curve to the left, the market needs to adjust more quickly to housing demand. The availability curve is shifted by developers responding to market demand and development costs. However, development firms are obviously not responding completely to low and moderate income housing needs, perhaps because of unprofitability, perhaps because of land use constraints. Governmental policy responses could relax land use constraints, reduce taxes and requirements on construction, reduce assessments or impact fees, subsidize housing production, or subsidize housing entitlement programs.[5]

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[5] Some amount of filtering down of high priced homes to lower incomes is usually assumed to take place, but this needs to be measured. The new phenomenon of "filtering up" or gentrification is also present, displacing poorer urban dwellers by higher income families, especially double-income households. See: Baer, Willliam C., "The Shadow Market in Housing," Scientific American, November 1986, pp. 29-35

The Affordability/Availability Gap (housing-rich, jobs-poor subregion):

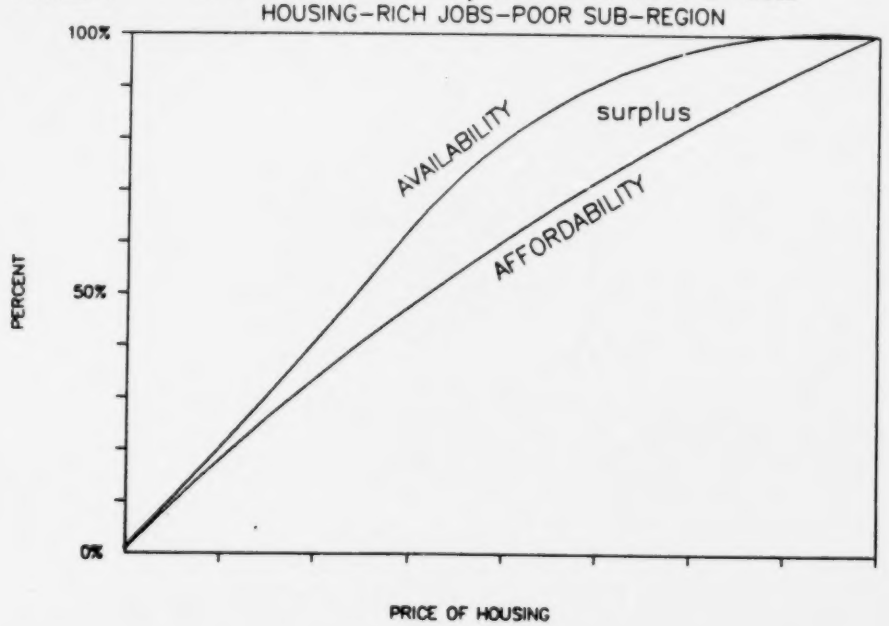
A graph of the affordability/availability gap for a housing-rich and jobs-poor sub-region shows a different shape. As shown in **Figure 4**, the J/H range may show the availability curve over the affordability curve.

Housing-rich suburban "bedroom communities" may have a surplus of housing and a shortage of lower-income jobs and households. More than enough housing is available to the suburban workers and their households, but there are not enough workers in the area to buy the housing. Therefore, the situation results in commuting to and from the suburban sub-region.

Impoverished urban areas of poor housing stock and low housing price may show a wide gap as well. The area could be housing-rich in quantity but not quality. The area could also be jobs-poor in terms of quantity, but the jobs could be high paying.

This study does not pursue policy making for housing-rich, jobs-poor areas. A housing-rich community could need more business, with a higher salary mix to bring about a better J/HB. However, increased employment generation may not be the best policy in terms of air quality improvement. Also, increased suburban business probably has a multiplier effect on housing generation as well. In any case, policy making for housing-rich sub-regions needs further study.

FIGURE 4 AFFORDABILITY/AVAILABILITY GAP



II.4. THE J/H RANGE -- ADVANTAGES AND DISADVANTAGES

The J/H range adequately measures current and projected new development effects on the imbalance between ranges of household incomes and housing price. This is the reason why the range is a clear improvement over the J/H ration. The extra data which is needed is fairly easy to obtain, since it is collected for the census, housing needs assessments, environmental impact reviews, and real estate and development industry market research.

The J/H range is used with a sub-regional commuteshed approach to define "nearness-to-work." Unfortunately, the J/H range does not adequately measure non-work-trips such as shopping, daycare, errand or leisure commutes. Nor does it specify what constitutes nearness-to-work for two or three worker households.

The most serious criticism is that the J/H range indicator still suffers from inability to define the multiple substitutes or choices which a consumer can make. The multiple consumer options cause indeterminate results from land use measures. As mentioned above, some households choose greater or shorter distances than predicted because of personal preferences for size, type and location of housing. The range definition, like the ratio definition, fails to fully model the potential movement of households within the housing market. It is for this reason that jobs/housing measures talk about "housing opportunities" and "job opportunities" instead of predicting actual population shifts.

Nonetheless, the J/H range definition deals with the complexity of affordability and availability and encourages market-based approaches. It is an improvement over variations of the J/H ratio. **If a regional agency or city is going to use an indicator of the jobs/housing balance in land use control measures, then the J/H range is recommended.**

II.5. A SUB-REGION'S ACTUAL J/H RANGE

Recent actual data are collected for this study to verify the hypothesis of a gap between affordability and availability in a jobs-rich area. The data verifies the affordability/availability gap for Contra Costa County projected for the years 1985 to 1995. The gap is surprisingly strong at a very wide price range for new homes, indicating that affordable housing opportunities are not available for a wide range of household incomes. The existence of the gap suggests that regional air quality planners should be sensitive to the levels of household income and to the prices of housing when developing land use control measures.

The affordability curve in **Figure 5** for most of Contra Costa County is assembled from data gathered by the Association of Bay Area Governments.[6] The data is based on the 1980 census worker-per-household data and projections of regional job growth. Projections of new workers from job growth are converted into a range of household incomes for the years 1985-1995 in 1987 dollars. Income distribution was converted to the affordability curve by multiplying yearly income by the 3.5 rule of thumb.

Figure 6 shows availability of new homes for Contra Costa, six counties of the San Francisco Bay Area and California aggregated over the years 1982-1987. **Figure 7** shows availability curves for resale homes for the entire Bay Area and California from 1987 sales through the Multiple Listing Service (MLS). Not surprisingly, housing prices are higher for the Bay Area and Contra Costa than all of California at every percentile of both resale and new home sales.

The new home and resale home data sets are somewhat overlapping, but neither data set is exhaustive, so both are presented.[7] New home prices are less than resale prices. This probably reflects location, lot size, floor space and construction quality. New home prices are also uncorrected for inflation (which was higher for housing than the rest of the economy). However, two low cost housing counties are not included in the new home data.

Figure 8 graphs the Contra Costa County affordability/availability gap as measured by new home prices. New home prices are chosen as the availability indicator because they may represent the increment of new housing on the market which will house the increment of new workers. Implicit in using this data is an assumption that the reasonable commuteshed for the high growth areas of Contra Costa County is the entire county.

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[6] Association of Bay Area Governments, Jobs/Housing Balance for Traffic Mitigation, Oakland, CA, November 1985.

[7] New home prices for 1987 were obtained from the Construction Industry Research Board, "Characteristics of New Homes Sold: California and Selected Counties, 1982-1987," and with the help of Ben Bartolotto at CIRB. The 1987 distribution of percentage of new home sales price ranges was divided by 1986 distribution of permits issued. No adjustment for inflation is made for the six year period, and Solano and Napa counties are excluded.

Information on resale home prices was provided by the California Association of Realtors with the help of Philip Glynn. This data captures about 90% of resales, ignoring non-realtor sales which may be at lower prices.

The availability curve is consistently to the right of the affordability curve. Reading across, an affordability gap exists for households at every income percentile up to about 82 percentile or $210,000 price. A surplus of housing for the highest 18 percentile income group seems to exist. The accuracy of the surplus for households who can afford over $230,000 housing price cannot be defended because the $400,000 endpoint was fictitiously created to standardize the data sets. The shape of the availability curve between $230,000 and $400,000 housing points is speculative.[8]

The entire Contra Costa County is by no means a properly defined sub-regional commuteshed defining acceptable commutes to work. It does not take into account reasonable bus, BART and highway commutes into the region or unreasonable added commute time from congested rural thoroughfares. The point is, however, that the methodology of the J/H range appears to work with sub-regional data. Data gathering is difficult because new home, resale and rental data sets do not exist or are not easily compatible.

Furthermore, the comparison of new households and new housing (measured by recent new homes) is a crude approach. Actual projections of future market prices for housing are needed. Also, current jobs/housing imbalances already exist on the margin where residents naturally move, and should not be ignored.

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8 The rental market is assumed to be reflected in the sales prices of homes (which include condominiums and apartment buildings). This assumption may lead to overestimates of housing costs for renters. On the other hand, the assumption that a household can afford 3.5 times its yearly income for a housing price is liberal. It is hoped that the assumptions counterbalance each other: there are overestimates of affordability from lack of specific rental market information and underestimates of affordability from the 3.5 factor rule.

FIGURE 5 CONTRA COSTA AFFORDABILITY CURVE

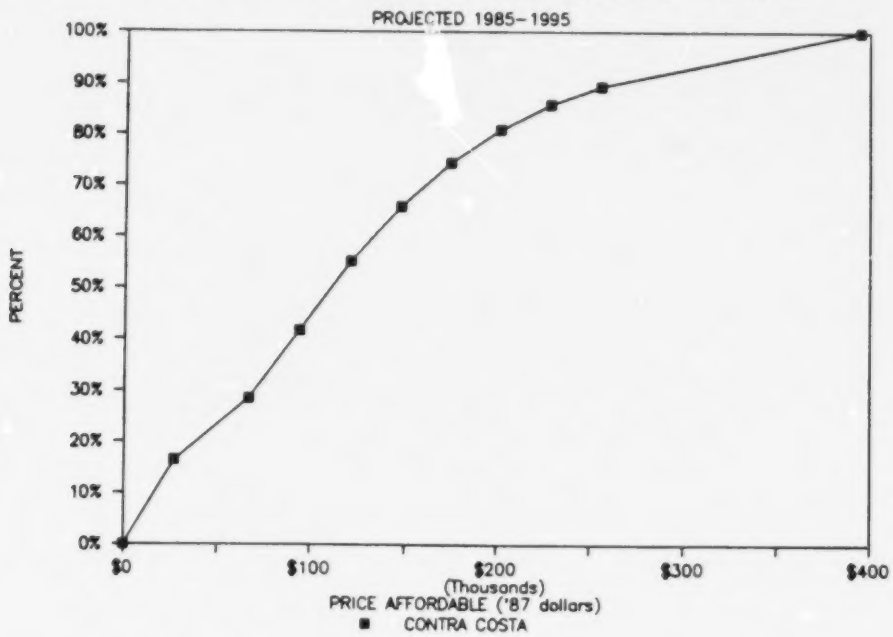


FIGURE 6 NEW HOME PRICES 1982-1987

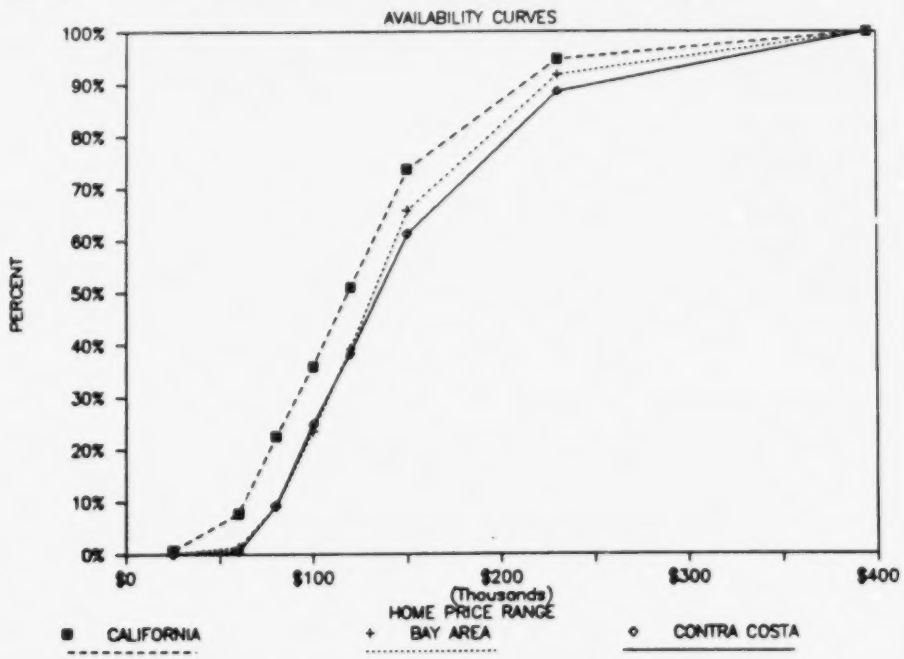


FIGURE 7

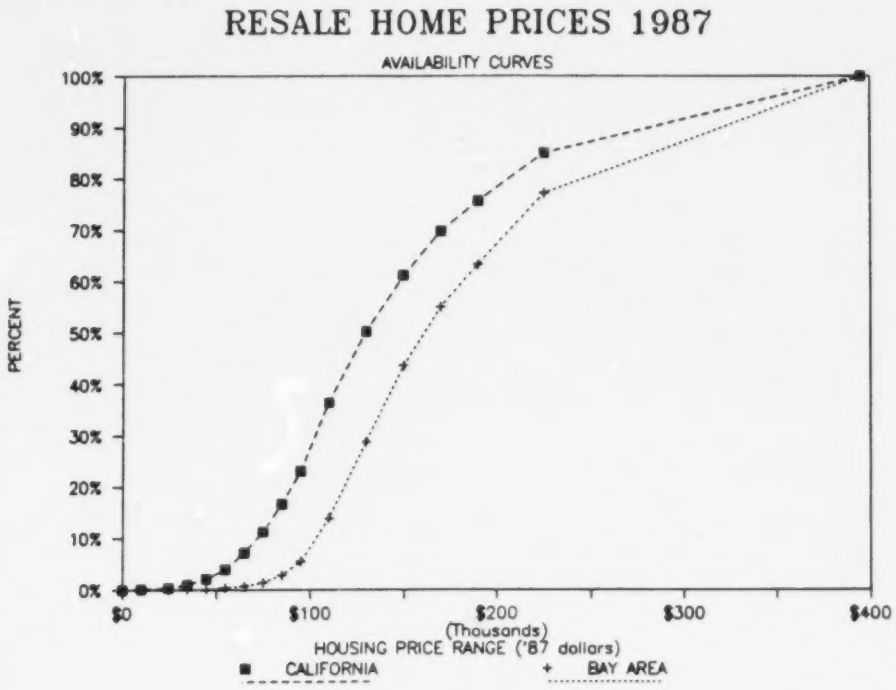
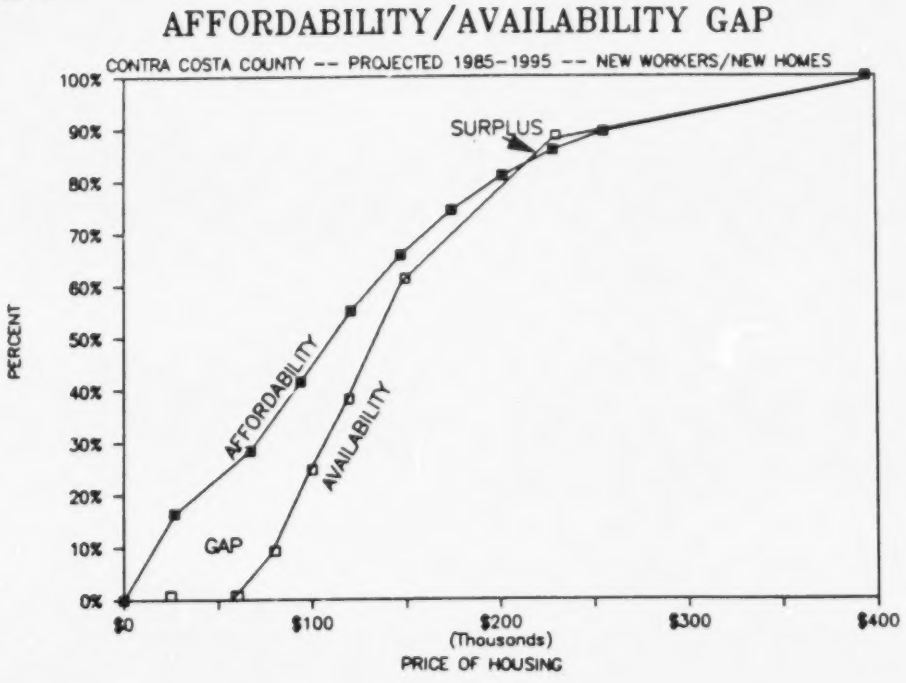


FIGURE 8



II.6. POLICY CONCLUSIONS FROM CONSUMER CHOICE PRICE MODELS

A more sophisticated and difficult analysis of housing choices than either the J/H ratio or range is discussed in APPENDIX A. The appendix discusses hedonic price theory, the push-pull gravity model, and the logit and probit data analysis methods. These economic based models can provide information for policy analysis generally through regression analysis which can indicate the effects of variables through the sign changes of coefficients. The difficulty of data gathering, data purification and model specification for these methods have limited their current usefulness in actually developing measurable and enforceable indicators.

One of the warnings to policy makers is that higher income consumers have an insatiable appetite for quality housing and choice locations. They can and do out-bid lower income households and drive them from areas of the market. Historically, higher income households have chosen further commute distances in order to obtain large lots, large houses, good schools, low crime and other suburban amenities. This fact suggests that negative attributes -- such as denser zoning, congested mixed use developments, smaller lots, smaller units, and environmental and social problems which accompany many subsidized housing developments -- are in fact the only effective barrier to the buying power of higher income households.

However, too much investment potential or too many amenities in affordable housing will give incentive again for higher incomes to buy up the affordable housing in near-commute areas. Luxury units can attract higher income households to urban markets. That attraction does not necessarily help improve the J/H range indicator because an entire range of households needs to be attracted to the urban market. When constructing affordable housing for lower income households, luxuries should be avoided so as not to foil promotion of the right mix of income levels. Lower income consumers may be the most willing to live in denser housing areas because it fits their other needs better, not because they prefer denser housing.

The last few sections have offered definitions and indicators of the J/HB. The next sections begin to apply the J/H range to policy development of land use control measures.

III. APPLYING THE INDICATORS TO CONTROL MEASURES

III.1. CRITERIA FOR MEASURABLE AND ENFORCEABLE MEASURES

J/HB based policy measures must be measurable and enforceable by the governmental authorities which administer them. The next several sections look at methods and problems in applying indicators to land use control measures. **APPENDIX B** also provides background on land use controls.

The following criteria should be met by land use control measures for EPA approval of their inclusion in the State Implementation Plan (SIP):[9]

- Measure description and estimated emission reduction benefits;
- Adoption by jurisdictions with legal authority to commit to and execute the measure;
- Evidence that funding is obligated to implement the measure; and that other resources are committed;
- Implementing agency's approvals from all appropriate government agencies;
- Implementing agency's enforceable schedule for transportation control measure or land use control measure planning, engineering, development, and construction (if necessary);
- Description of a monitoring program to assess the measure's effectiveness and to correct problems;
- Contingency measures and commitment to implement these measures;

Other criteria that are important for J/HB based measures in particular are:

- Clear recommendations on the application of the land use control measure to local, sub-regional or region-wide levels. Jobs and housing markets are region-wide. Housing locational amenities are often related to local or municipal settings. Workers prefer commuting in sub-regional commutesheds or transportation corridors near to work -- which is what policy makers like as well.
- Adequate models to predict other outcomes besides housing, air quality, commute time, and transportation capacity. The full effect of land use control measures does not have to be predicted before enactment, but a rough outline of possibilities would be helpful.

  Outcomes could include: long term effects on transportation infrastructure and capacity; energy conservation; income redistribution from rezoning and subsidies; increased regional centralization; decreased leap-frogging; increased clustering of development; shifts in societal values for housing density and commute patterns; decreased population growth and regional immigration; effects on household formation and size; economic losses from inefficient subsidy, taxation, and lost growth; shifts in regional cooperation and balance of powers.

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[9] Portions of this section are adapted from a draft of work by Systems Analysis Incorporated (SAI) on TCM technical guidance prepared for EPA, Region IX, Air Management Division.

III.2. ENFORCEMENT MECHANISMS

Enforcement mechanisms for land use measures include timely implementation, proper authority and jurisdiction, and monitoring or accountability. This section outlines these general steps of enforcement.

The state, APCDs and regional agencies need to determine the J/H ratios and ranges for cities, counties, sub-regional commuting areas, and for the entire region.[10] The same information is needed for projections of future growth. To ensure effective and consistent implementation, new development sites should be reviewed by the region wide planning agency. They should be reviewed for their own balance and their projected effect on local, sub-regional and regional balance. Primary enforcement responsibility over the local governments should be with the APCDs, but the districts unfortunately currently lack the resources and expertise for such work.

The ratio and the range can serve the following purposes:

- **Triggers** for application of land use control measures. Current or projected levels of imbalance could trigger requirements for municipalities or counties to construct packages of land use measures.

- **Goals** as to which type of land use control measures to apply and where to apply them. Should there be stress on jobs placement, housing placement or other problems? Goals could be set for new developments, for development areas, for zoning areas, for clusters of new developments, transit nodes or for entire jurisdictions. The current range can be used mathematically to derive limits on future housing or job production. This methodology will be described in the next section.

- **Monitoring mechanisms.** Local jurisdictions report to regional air districts on local zoning, housing subsidies, business incentives and regional growth as they relate to improving the J/HB.

Is the use of an indicator as a goal or trigger an enforceable mechanism? The California Clean Air Act 1988 (also called the "Sher Bill") allows for indirect source review. However, that power is modified by Section 9.40716(a):

> Nothing in this section constitutes an infringement on the existing authority of counties and cities to plan or control land use, and nothing in this section provides or transfers new authority over such land use to a district.

It is the city or county which continues to control land use, zoning, housing subsidy disbursement, and job siting. Therefore, the J/HB indicators need to have meaning for these

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[10] In California, regional agencies already assess housing needs for all regional jurisdictions. The Southern California Association of Governments has computed J/H ratios for sub-regions and projections of sub-regional job, housing and population growth. ABAG has calculated housing affordability for the Bay Area.

jurisdictions in their enforceable policies. The package of zoning and housing subsidy measures which could be put into place by the city can be called the **"local land use control bubble"**. It is feasible for the APCD to set goals through assigning a bubble to local jurisdictions. Assistance is needed from the regional planning agency and transportation authority.

Such a bubble is suggested below in **Part IV**, where it is called a **"housing density bubble"** for a jobs-rich commute area. A land use control bubble could define goals for housing and job growth for jurisdictions to meet through zoning, land use and subsidies of housing or commercial development.

It needs to be reviewed and determined by ARB and EPA legal counsel as to whether zoning and land use goals set by regional APCDs constitute an "infringement" on local control as quoted above from the Sher Bill. Other legislative mandates given to the ARB may provide authority and countervailing public purpose for intervention by regional and state authorities.

III.3. HOW TO SET GOALS WITH THE J/H RANGE

The previous section recommended enforcement of J/HB improvement through using the indicators as triggers, goals and monitoring mechanisms. This section shows how to use the J/H range indicator for setting goals for a new development site.

This example is applied to a jobs-rich, housing-poor sub-region. The "area" under consideration is an estimated sub-regional commute area around the project. The area could be estimated by outlining an average time length car commute or a walk and transit commute around the project.

At each income level, the inverse of the current area ratio is a goal for future development. The ratio at each income level should not be confused with any of the J/H ratios discussed previously; the **J/H range consists of a series of ratios in each income level** between quantity of affordable units demanded and quantity of available units.

The matrix in **Table 1** displays the variety of projected and current relations of jobs and housing. The "jobs" data refer to the number of households who live in the sub-regional area or who will move to the area because of job generation. The jobs are cross-tabulated with household income levels to show what households can afford.

The number of housing units are cross-tabulated with household income levels to show the number of housing units available to households in their price range.

The salient lines of the application matrix are filled in with fictional data for a project. If the project is developed with a J/H range as shown it will cause a net improvement on the current area J/H range.

The regional or local review agency favors a net improvement on the current imbalance. A strong requirement on the developers uses the inverse of the ratios across the

current area J/H range as a goal for the projected site J/H range.

For example, since the current area ratio is 1.6 at the very low income range (below 60% of median), then for new development at the site the allowable ratio is 1/1.6=.63. For each new housing unit for very low incomes, only .63 households are allowed to be generated by jobs growth.

For the high income range (above 120% of median) the current area ratio is 1.19. The allowable ratio for projected new site development is 1/1.19=.84.

This goal-setting methodology allows the developer to determine the size of the development in either number of housing units or jobs, unless the developer wishes to exceed the housing goals or job limitation goals voluntarily. **The income distribution of current jobs in the area should dictate the distribution of housing at the new site.**

For example, the current jobs distribution across incomes is .3,.3,.2,.2 for 1,000,000 jobs. When the developer chooses a specific number of housing units, the projected new site housing distribution should match that distribution of housing need at .3,.3,.2,.2. Once the developer chooses a suitable total number of housing units (1000), then the income distribution of jobs generated by the project will be forced by the J/H ratios (across the J/H range) and the distribution of housing units.

Selection of the total number of projected site jobs (460) also has to match-up with a similar distribution of housing units (.3,.3,.2,.2) in such a way that the allowable projected J/H range sets goals for the distribution of the 460 jobs.

In a typical jobs-rich sub-region this goal-setting methodology maximizes the upper income job generation while improving housing opportunities for lower income families. On the negative side, it requires mixed use development, mixed income housing and mixed job income levels. Some developers may consider this to be an unfair burden on the marginal developer which previous developers did not face. Local governments may alleviate this burden for the developer and help the lower incomes at the same time by focusing housing subsidies on new developments. In today's market, providing 60% of the new development units to very low and low income is not practical without deep levels of subsidy.

APCDs and local governments need to decide how strictly to enforce such a forced matrix. The matrix may also be applied to set goals for zoning density increases in acceptable walking distances around mass transit. Such a land use control measure is discussed fully in the next section.

TABLE 1.

MATRIX FOR GOAL-SETTING WITH THE JOBS/HOUSING RANGE

		INCOME LEVELS AS PERCENT OF MEDIAN			
		VERY LOW	LOW	MODERATE	HIGH
	TOTAL	BELOW 60% MEDIAN INCOME	60%-80% MEDIAN INCOME	80%-120% MEDIAN INCOME	ABOVE 120% MEDIAN
PROJECTED JOBS					
SITE	710	188	188	168	168
CITY					
AREA					
PROJECTED HOUSING					
SITE	1000	300	300	200	200
CITY					
AREA					
PROJECTED RANGE (a ratio at each income)					
SITE	0.71	0.63	0.63	0.84	0.84
CITY	(irrelevant)				
AREA					
CURRENT JOBS					
SITE					
CITY					
AREA	1000000	300000	300000	200000	200000
CURRENT HOUSING					
SITE					
CITY					
AREA	710332	187500	187500	167666	167666
CURRENT RANGE (a ratio at each income)					
SITE					
CITY					
AREA	1.41	1.60	1.60	1.19	1.19
	(irrelevant)				

NOTE: "JOBS" is indicated by households earning each income.
"HOUSING" is indicated by housing available,
at a price affordable to each income.
The total ratio is the J/H ratio and is irrelevant for goal-setting.

IV. A MEASURE USING THE JOBS/HOUSING RANGE: PROMOTE HIGHER DENSITY RESIDENTIAL ZONING NEAR TRANSIT NODES

DESCRIPTION

This section describes a J/HB based land use control measure. The measure applies to a jobs-rich, housing-poor sub-region. The measure is described as if it is already in place.

Cities, counties and new development projects promote higher density residential zoning near transit nodes. The ideal is to develop moderate-to-high density low-and-moderate income housing within walking and bicycle distance of mass transit. This measure promotes dense "origination" of mass transit passengers who can avoid emissions from cold-starts and long commutes.

Transit nodes of interest are defined by the APCD with the assistance of the regional transportation and growth planning agencies. Transit nodes include light rail, rapid transit and major bus stations. Local municipalities and counties are asked to implement a particular **"land use control bubble"** to promote denser housing near the transit node. Since this particular bubble promotes denser and more affordable housing than the current zoning, it is called a **"housing density bubble."**

Zoned densities are moderate to high density. Local policies usually include requirements for low and moderate income subsidies, inclusionary zoning and density bonuses for commitments to keeping units affordable to lower incomes.

EXAMPLE

This type of measure is perennially discussed at the time of construction of rapid and light rail transit, such as BART, the South Coast Rapid Transit or the new San Jose light rail. Marin County adopted a **"pedestrian pocket"** as one of three preferred development alternatives in its 1988 General Plan. Architect Peter Calthorpe describes the pedestrian pocket:

> Much smaller than a New Town, the Pedestrian Pocket is defined as a balanced, mixed-use area within a quarter mile walking radius of a light-rail station. The uses within this zone of approximately 50 acres to 120 acres would include housing, back offices, retail, daycare, recreation and open space.
>
> Up to 2,000 units of housing and 1 million square feet of office can be located within three blocks of the light-rail station using typical condominium densities and four story office configurations.[11]

In this pedestrian pocket configuration, housing densities are 17 to 40 units per acre. Zoning does not have to be single-use housing to bring about an improvement in the J/HB.

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[11] Calthorpe, Peter and Mark Mack, "Pedestrian Pockets: New Strategies for Suburban Growth", Northern California Real Estate Journal, Vol. 2, No. 11, Feb. 1, 1988, pp. 1+.

However, sufficient housing must be allowed and encouraged in the transit node area along with business.

Plans for a Marin-Sonoma light rail corridor include discussions of greater development densities along the corridor. In a review of environmental issues it was concluded that "The net effect of this added pressure for high density development around rail stations could be to redistribute planned growth rather than induce additional growth."[12] Economic value is inevitably generated to surrounding land through nearby transit construction. A result of denser zoning of pedestrian pockets is to convert that value into housing instead of purely commercial development.

IMPLEMENTATION

1. APCDs with the assistance of the regional transportation authority identify appropriate regional transit nodes, corridors and stations. Regional rapid transit stations are obvious candidates as appropriate nodes. Transfer points and origination points of bus lines on feeder thoroughfares are also obvious candidates.

2. The APCD, with the assistance of the regional planning agency, identifies moderate and high density goals for areas surrounding the transit nodes. The regional planning agency may wish to report the goals in the regional Growth Management Plan. The regional Growth Management Plan could show computation of sub-regional and municipal goals for "net improvement" or "no net worsening" of J/HB in the transit corridor for each transit node. In effect, each transit node area is assigned a "housing density bubble" in which denser residential zoning and housing subsidies are achieved. The section below, entitled "USE OF THE J/HB INDICATORS," describes the goal-setting for each node in more detail.

   Two studies point to a five minute walk or 1,000 to 1,800 feet as the distance from a transit node in which impacts are normally noticed.[13] Such a distance adds up to three to nine city blocks.

3. Local jurisdictions change land use plans and zoning to allow housing development as defined by the "housing density bubble." City and county General Plans conform with the goals set in regional Growth Management Plans. A statement of conformity with regional plans is made in the General Plan.

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[12] Memo to members of the Highway 101 Corridor Action Committee from Robert L. Harrison, Consultant Team Project Manager, Sept. 6, 1988.

[13] Ganon, Colin A. and M. Dear (1972), "The Impact of Rail Rapid Transit Systems on Commercial Office Development: the Case of the Philadelphia-Lindenwold Speedline," for the U.S. Department of Transportation, Philadelphia: University of Pennsylvania.

Marcou, O'Leary & Associates (1971). "Transit Impact on Land Development." Washington, D.C. (unpublished).

The studies look at impacts of transit nodes on walks to commercial job sites, but it seems logical for acceptable walking distances to be the same on the origination end of commutes.

4. Municipalities and counties design and report to the APCD a package of zoning, General Plan and housing subsidy policies which constitute "housing density bubble policies." The General Plan for cities and counties show a commitment to meeting the goals of the "housing density bubble."[14] Zoning laws are promulgated by cities and counties in conformity with the General Plan. Jurisdictions have flexibility as to which zoning or housing subsidy options they choose to implement.

Zoned densities are moderate to high density. As to what constitutes "moderate" or "high" density, that depends on the relative densities in the jurisdiction. 17 to 40 units per acre is suggested by Calthorpe, but densities could be much greater. Densities can be defined by number of units per lot or acre, or by number of people per acre.

Actual housing densities are more likely to be built when the zoning densities are tied to low and moderate income subsidies, inclusionary zoning and density bonuses for resident income commitments. Some of the zoning possibilities are itemized below. Housing subsidies are outlined in a later section.

Higher density zoning
Zoning changes are made to increase residential densities -- in decreasing amounts as distance from the transit node increases.

Facilitate conditional uses near transit nodes
Conditional uses for denser development are often sought by developers to realize economies of scale and to maximize land values. Near transit nodes such conditional uses should be granted as a matter of right unless significant environmental impacts are shown.

Inclusionary zoning
Inclusionary zoning is a requirement upon new developments that a certain percentage of units in a residential project must be committed to affordable housing (low and moderate income prices). In a commercial project, a number of affordable units are required per lot size or in relation to the floor size of the development. Usually, such requirements are tradable to other locations or they can be bought off by payments to housing subsidy funds.

Tradable requirements are likewise limited to other locations near transit nodes. Buy-offs into the housing fund are designated for subsidies which are also near the transit node.

Density bonuses
Density bonuses are given to builders for commitments to low and moderate income units. This lowers the price of land per unit and makes affordable housing development more possible.

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[14] J/HB based policies could be placed in the housing, population, land use, air quality, environmental or its own proper element in a general plan. The consistency requirements make the element location theoretically irrelevant. California Assemblyman Cortese's AB2203 proposes a mandatory air quality element. If the ARB were to prepare guidelines for the element, they could consider requiring a J/HB based goal such as the "housing density bubble."

AUTHORITIES AND JURISDICTION

The APCD submits this land use control measure as a potential SIP measure or rule. Some APCDs may have differing enforcement authority over local governments. The APCD contracts with the regional transportation planning authority to identify appropriate transit nodes. The APCD contracts with the regional planning agency to create density goals for each corridor.

The major authority for this measure, however, rests with the local jurisdictions which plan and create land use zones.

USE OF THE J/HB INDICATORS

The J/HB indicators show the need for this measure, and thus serve as justification for it. Regional planners could delimit a commute area including all business destinations and all workers/households within walking distances to transit nodes on the transit system. The J/H range indicator shows whether there is need for further housing development within the mass transit/walking commuteshed. The indicator thus shows either "need" or "no need" for this measure.

The J/H range also shows what quality or price of housing should be encouraged at each transit node. The income levels of projected jobs within walking distance of the transit system assist in setting goals for income sensitive availability of units near the transit nodes. The methodology for such goal setting is set forth in section III.3 above, **"HOW TO SET GOALS WITH THE J/H RANGE."**

ACCOUNTABILITY AND MONITORING

Accountability rests with the local jurisdictions for meeting the "housing density bubble" through *General Plan, land use and zoning policies*. They report their package of zoning measures which would meet the density goals. APCDs are accountable for illustrating the appropriate transit nodes and applying the J/HB data to setting transit node goals for each jurisdiction.

The APCD reviews the density goals of the local jurisdictions.

ENFORCEMENT

Enforcement comes into play if a local jurisdiction fails to submit a suitable package of zoning measures to reach housing density goals. One of the strongest enforcement tool is through environmental impact reviews. E.I.S. and E.I.R. reviews look for projected housing densities in planned unit developments (P.U.D.s) to conform to "housing density bubble" goals.

Federal municipal sewer grants and federal highway funds are held up on districts that refuse to write adequate SIPs. There is also the threat through court cases or EPA action of a Federal Improvement Plan (FIP).

ECONOMIC JUSTIFICATION

This measure is economically efficient for the region because it encourages cities to be responsible for creating housing opportunities to match job and transportation development. The measure internalizes negative effects of development in the project, city and region. The measure maximizes economic development while providing a full range of housing prices, if the goal-setting methodology previously described is used.

This measure is economically equitable because it encourages public policy focus on the needs of low and moderate income households who are being shut out of urban markets or over-paying for housing.

This measure is fair to current property owners because it increases their land value through creation of the right to build denser housing. Some property owners may not want this right, because their single-family or low density buildings lose their "livability" use value as neighborhood densities increase. The measure is not fair to such owners who prefer the zoning and housing status quo.

COSTS AND BENEFITS

There are costs in regional and local rule-writing and costs of loss of commercial and single-family (low density) land use rights. There are benefits: in air pollution reduction from reduced car commutes; in value gain for landowners in upzoning from single-family residential to higher densities; in further availability of affordable housing; in reduced traffic congestion; and in saving of non-renewable fuel sources.

FINANCING

This measure is relatively low cost in that it is inexpensive to rewrite zoning laws and redirect current housing subsidies to appropriate transit node areas. The major financing cost is in administrative costs to the local jurisdiction's planning agency and to the regional APCD and contractual planners. Financing is from federal contracts, state funding and air discharge permit fees. Under the California Sher Bill, Section 42311(a), the ARB may levy fees to cover costs of regulating area wide or indirect emission sources.

AIR QUALITY IMPROVEMENT PROJECTIONS

Improvements on air quality are not forced by this measure, they are offered as housing opportunities. The households who choose to live in the denser zoning bubble areas may or may not use the nearby mass transit. **APPENDIX A** describes models of consumer choice in residential decisions which can contribute to models for projecting air quality improvement. The salient question is: how much of the increased near housing opportunity or near job opportunity is used by workers who prefer to live near to jobs?

In the long run, the locational amenity of "nearness to work" draws transit users to the denser housing bubble area. The negative attributes of dense urban living (transit noise and foot traffic, no private lawns, cheaper and smaller units) keeps prices relatively affordable.

Improvement on air quality is only measurable in the long term of five to twenty years or more. Inclusionary zoning and refocused subsidies affect actual built densities only after a period of housing construction. Many of the lots are not buildable until after tenants completely vacate (depending on eviction protections) or after owner-occupants sell to developers.

OTHER OUTCOMES (EXTERNALITIES)

Some predictions of other outcomes are: better utilization of mass transit infrastructure; income growth to landowners; increased centralization of regional housing densities; and greater regional agency influence over local zoning and housing placement decisions.

V. SELECTED J/HB BASED CONTROL MEASURES

In general, in California, the APCDs have been taking stronger roles in setting goals for local jurisdictions -- while shying away from direct implementation of the measures. The previous transit node measure and the following suggestions are offered in this same spirit. Regional authorities can set goals using J/HB indicators. Local jurisdictions and the private sector can implement.

Following is a list of potential J/HB based land use control measures. They are only briefly introduced and need extensive investigation. They can be logically categorized into sectors of demand and supply in the market. The economic typology of measures includes:

- **zoning measures,**
- **housing production measures,**
- **jobs and industrial placement measures,** and
- **trip reduction or distance impedance measures.**

V.1. ZONING MEASURES

Zoning measures affect the supply of land with designated uses. Zoning is usually a low cost measure because it involves lifting or putting restrictions on the use of privately held land.

- **PROMOTE HIGHER DENSITY RESIDENTIAL ZONING IN DOWNTOWN AND COMMERCIAL CENTERS**
  This measure is similar to the "transit node" measure in that it encourages walking or biking commutes to work. It thus avoids the uncertainty of other land use measures which may still allow short car commutes (and therefore cold-starts). Studies by Kenworthy and Newman have demonstrated the correlation of greater population densities in city centers with reduced gasoline consumption per capita.[15] "Reduced gasoline consumption" measures reduction of air pollution, just as do commute distances, times, or trips.

- **MIXED USE: PROMOTE HIGH DENSITY RESIDENTIAL ZONING IN NEW COMMERCIAL DEVELOPMENTS**
  This is probably the most often mentioned land use control measure. Many developers fear that office development with housing is unattractive or a poor use of valuable commercial land.

- **CREATION AND ENFORCEMENT OF CONTROLS ON CONVERSION FROM RESIDENTIAL TO COMMERCIAL**
  Illegal conversions of units from residential use need to be monitored and prevented. Second floor residential on neighborhood commercial strips are being lost. Residential hotels, a valuable source of low-income housing, are being lost to tourist uses. Older rooming houses are being converted to bed-and-breakfast inns.

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[15] Newman, Peter W. G., and Jeffrey R. Kenworthy, "Gasoline Consumption and Cities: a Comparison of U.S. Cities with a Global Survey," APA Journal, Winter 1989, pp. 24-37. This includes an excellent bibliography of land use and transportation relations.

- **ENCOURAGE CONVERSION OF COMMERCIAL/INDUSTRIAL USES TO RESIDENTIAL**
  Older industrial cities which are now experiencing a shortage of available land for housing development would do well to inventory their supply of commercial/industrial land. There is often an excess capacity of such land. General plans and zoning ordinances could encourage conversion of under-utilized commercial/industrial land for housing uses. A prime example of such conversion is the process now underway to convert old railroad and warehouse land in San Francisco's Mission Bay to a balanced use of commercial, retail, open space and housing uses.

- **ENCOURAGE IN-FILL HOUSING DEVELOPMENT**
  This perennial measure could help increase population densities to support mass transit and urban and suburban infrastructures.

V.2. HOUSING PRODUCTION MEASURES

Housing production measures affect the supply of affordable housing or subsidize the demand for housing. J/HB based housing production measures should concentrate on low and moderate income housing supply and demand if that is indicated by the J/H range affordability/availability gap.

- **PROMOTE PLACEMENT OF SUBSIDIZED HOUSEHOLDS CLOSER TO WORK AND ACTIVITY SITES**
  Housing grants to households would be more efficient if for little added cost they would improve the ability of low income families to find locations nearer to there place of work or other activities. Current housing subsidies do not inspect the effects on J/HB in dispensing grants and loans. However, housing subsidies already target the exact populations that are the most displaced by the imperfections in the housing market.

  The Department of Housing and Urban Development (HUD), state departments for housing and community development, housing finance authorities, municipalities and counties administer subsidy programs. Public Housing Authorities, redevelopment authorities, non-profits and profit-making firms implement the subsidies. All these actors could inspect the effects on J/HB as a criteria for dispensing monies and selecting projects. The air quality authorities could seek effective prioritizing by housing agencies of locational preferences. Of course, agencies would need to remain sensitive to other goals, such as promotion of open housing.

- **FIRST TIME HOMEBUYER PROGRAMS WHICH PROMOTE LOCATIONAL CHOICE**
  First-time homebuyers are the least likely to buy housing near their preferred location. (For some, the preferred location may be farther from work, in that suburban locations may be preferable.) APCDs could encourage first-time homebuyer subsidies with incentives for buying near workplaces of the homebuyers.

- **LIMITED EQUITY OWNERSHIP OF HOUSING**
  Encouragement of limited equity ownership discourages upper incomes from investing in accessible housing for the short term tax breaks and long term investment potential. The equity gained from inflation, speculative price rises, and rehabilitation is reverted back to the cooperative or housing agency upon resale. Therefore, the upper income households who out-bid others -- to capture the investment value of property -- will be discouraged from doing so.

V.3. JOB AND INDUSTRIAL PLACEMENT MEASURES

Job and industrial placement measures place work nearer to the home. Such strategies encourage economic development at the same time that they attempt to limit pollution and other commute affects. Were such a measure to be encouraged, there would be less demand for housing near the business site, and less travel demand as well.

There are potential criticisms of such measures -- even from a transportation perspective -- in that office growth in suburban bedroom communities may cause unwanted daytime traffic congestion, or "suburban gridlock." And new development in suburbs has a multiplier effect of causing additional unwanted development. Measures could promote work-at-home through telecommunications or flexible schedules.

V.4. TRIP REDUCTION OR DISTANCE IMPEDANCE MEASURES

Trip reduction or distance impedance measures cause a net reduction in travel demand. Any land use measures which encourage use of mass transit instead of driving should also be included in this type of measure. Growth controls, design and enforcement of urban limit lines and zoning for green belts and agricultural/open space impede aggregate distances to work. Such measures also could include any actions which encourage compact distances between job and housing sites, such as is found in promotion of mixed use development.

- **WAGE INCENTIVES FOR EMPLOYEES TO MOVE CLOSER TO THE JOB SITE** This measure is usually applied at the time of transfer to a new job site, otherwise it would not necessarily influence behavior. Several corporations and governmental agencies are experimenting with such programs. Such programs are easily attached as mitigations for new developments, especially if the employers are known in advance.

- **DESIGN AND ENFORCE URBAN LIMIT LINES. DESIGN AND ENFORCE GREEN BELTS THROUGH AGRICULTURAL AND OPEN SPACE ZONING.**
  Such measures design an absolute limit for urban sprawl. They thus put a cap on the distance of the longest commute, unless development is able to leapfrog over the greenbelt.

  The Bay Area Air Quality Management Plan of 1982 encourages 5,10 and 20 year phases of growth for LAFCOs using the "urban service area" concept. The plan suggests that, "counties and cities enact agricultural zoning or large-lot rural residential zoning (generally one dwelling unit per 40 acre minimum lot size)," for areas outside urban service areas.

  The plan also suggests that "counties and cities establish programs of public land management (including acquisition, purchase/leaseback, purchase/transfer of development rights, etc.) for locations outside urban areas."

VI. PREDICTIONS OF EFFECTS ON REGIONAL ORGANIZATION AND GREENBELT

This section predicts the effects of the proposed measures on regional political and social organization, including policies which promote greenbelts. The short term effect on regional infrastructure will be minimal, because of the slow effect of land use control measures. In the long term, densities near mass transit, freeways and main thoroughfares will increase. Housing will become more available in central business districts.

Developments will increase in the mix of housing, commercial and retail uses. The leap-frogging of development over open space will be avoided.

The suggested measures will encourage low and moderate income access to mass transit and jobs. Thus, the measures will slow down gentrification and displacement of lower incomes to areas of poor service, poor transportation accessibility, and greater distance from jobs. These measures will also accelerate tendencies of higher incomes to choose the longer commutes, larger lot sizes and larger units in more pastoral, suburban settings.

J/HB based measures will slow down decentralization of regions and increase residential densities near mass transit and freeways and main thoroughfares. Greenbelts, rural zones, open spaces and pastoral ex-urban areas will therefore be more possible and necessary. However, it is the upper incomes who will have the privilege of access to these environmental amenities. The low and moderate income households will instead enjoy the shorter work trip amenity.

There will be external effects on non-work travel, suburban growth, open space loss, and business traffic. These effects are beyond the scope of this work.

The involvement of regional authorities in developing these measures neither requires nor precludes steps towards regional government. There will necessarily be more cooperation among local governments in planning for development sites. The regional air authority, transportation authority, planning authority and local governments will perforce cooperate in data gathering and assessment of cumulative growth impacts. These measures lend themselves to an evolutionary development towards integration of regional authority in response to the existing regional housing market.

These predictions are speculative but reasonable. Before applying a land use control measure, the APCD, the ARB and EPA should predict as many future results as possible.

APPENDIX A:
MODELS OF CONSUMER CHOICE IN RESIDENTIAL LOCATION

A.1. ABSTRACT:

The purpose of **APPENDIX A** is to describe economic models of the housing market as background for defining the jobs/housing balance (J/HB) and its uses. In previous sections, the J/HB is defined as the availability of housing at an affordable price in a near, reasonable commute distance. Such a definition makes assumptions about affordability and reasonable commute distances which are inaccurate. Consumers choose distance from work and home price or rent as part of a bundle of housing attributes.

Hedonic price theory is presented in this appendix to describe the price elasticity of commute distance as one of many housing attribute preferences. This microeconomic model of demands for housing shows higher income families choosing farther commutes because of preferences for large lot sizes and neighborhood amenities.

Cervero's push-pull gravity model is presented but it fails to adequately specify an expression that takes account of regional markets and inexact data gathering.

A quantitative indicator of the jobs/housing imbalance is pursued through data base manipulations performed by the Association of Bay Area Governments. The definition approximates demand calculation by household incomes in the transportation corridor, but fails to model supply and therefore location choice.

Probit models of consumer choice and the logit method of data purification are methods for analysis which are still in development. The probit and logit models can be expensive and difficult to perform, but offer some hope for feasible measurement of choice and commute distance responses to price.

A.2. HEDONIC PRICE MODELS OF LOCATION CHOICE

Hedonic price theory models housing choice. It postulates that a consumer looks for and evaluates a bundle of structural factors and local amenities in the housing unit and land. Structural factors and local amenities together are called housing "attributes". One such attribute is distance to work, which can be measured in actual distance or in travel time. Travel time is dependent on mode of transportation.

The literature of hedonic pricing is recent but prodigious. A good starting place is through the work of William Alonso in urban land economics. Alonso developed the idea of a bid price curve:

> A bid price curve of a resident is the set of prices for land the individual could pay at various distances while deriving a constant level of satisfaction; that is to say, if price of land were to vary with distance in the manner described by the bid price curve, the individual would be indifferent among locations.[1]

Land size and distance from a city center are the only attributes in Alonso's simplest example. If market price accurately reflected these preferences, then a rent gradient can be plotted (with the same shape as the bid price curve) which shows price for the same size lot as a function of distance. A typical rent gradient is shown in Figure 9. The two curves reflect rent gradients for different sized lots. The two curves can also reflect willingness to pay (i.e. demand) for the same size lot by two "bidders" of different incomes.

The shape of a rent gradient changes when other attributes of housing are added to the calculations. For example, as shown in Figure 10, the locational amenity of nearness to a green belt raises the rent that a consumer is willing to pay.[2]

It is a unique characteristic of housing that its location is fixed. Therefore, locational amenities affix to the housing "bundle of goods", such as neighborhood desirability, school quality, and the nature of local government. Quigley says in a survey article:

> However important ... physical and structural components may be, household consumption of a variety of other goods is determined jointly with housing. Included in these goods are physical, locational, and neighborhood attributes, the character and quality of the local environment, and the public and social services provided to dwellings and their residents.[3]

The housing market consists not of a collection of a single good with one price as in most commodity markets. The housing market consists of a variety of housing unit "bundles" of housing attributes. In a summary article, Smith, Rosen and Fallis said:

> The housing unit (a bundle of characteristics) commands a price in the market. Various bundles and their associated prices reveal the implicit prices of characteristics, known as hedonic prices. Empirically, these hedonic prices can be determined from regressions of price on characteristics.[4]

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[1] Alonso, William, Location and Land Use, Harvard University Press, Cambridge, Mass., 1965, p.59

[2] Nelson, Arthur C., "Using Land Markets to Evaluate Urban Containment Programs", APA Journal, Spring 1986, p. 158

[3] Quigley, John M., "Housing Market Information and the Benefits of Housing Programs", Center for Real Estate and Urban Economics reprint series, no. 57, 1987, p. 53

[4] Smith, Lawrence B., Kenneth T. Rosen, and George Fallis, "Recent Developments in Economic Models of Housing Markets", Journal of Economic Literature, Vol. XXVI (March 1988), pp. 37

FIGURE 9 RENT GRADIENT

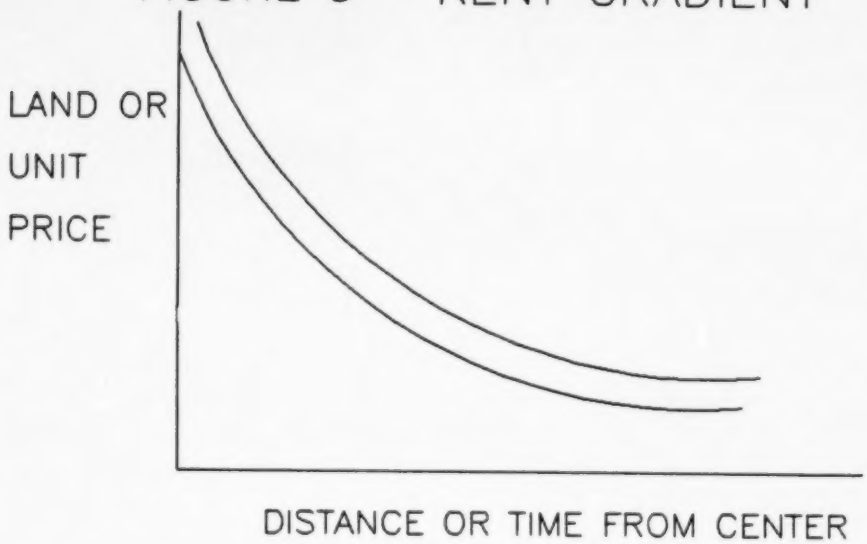
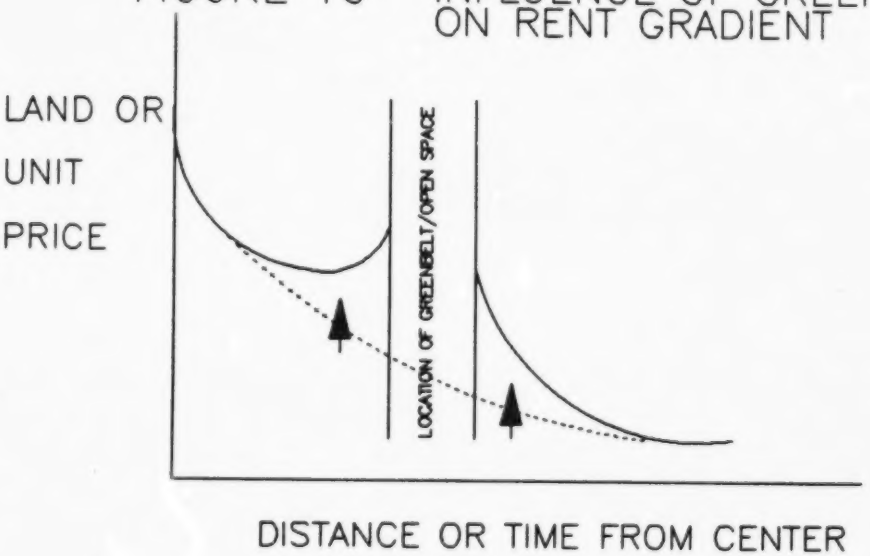


FIGURE 10 INFLUENCE OF GREENBELT ON RENT GRADIENT



Much work has in fact been done on estimating hedonic prices[5] Several serious problems persist. The theory is based on the idea of a radial commute to a central business district. The urban reality and spatial modelling show that many urban markets are complicated -- at best --by rings of suburban employment. Any lack of pattern in proximity to employment centers translates into unrecoverable error in estimating willingness-to-pay for commute amenities and other attributes.

Another problem is that attribute preferences may not be independent. To illustrate this problem, it can be postulated that Tiffany lamps in a suburban estate may be valued differently than the same attribute in a run-down studio apartment. Quigley concluded, "prices of housing attributes are not independent of one another."[6] This leads to non-linear housing price functions for attribute contributions to total value -- making it perhaps impossible to accurately measure cross-price elasticities of the housing market through regression analysis.

The hedonic price theory, with all its problems, is an extension of microeconomic theory which attempts to place a value on housing location among other housing goods. The price elasticity for locational choice is theoretically observable. That is to say, that willingness of a consumer to pay to live close to work is separable from other goods in the housing bundle. Similarly, it is theoretically possible to measure the commute response to a rise in price on residential location. The price elasticity of locational choice is the same as the marginal propensity to commute as a response to (exogenous) price rise in the housing bundle.

A.3. APPLICATION OF ECONOMIC MODELLING

Land use control measures for jobs/housing imbalance are discussed when regional economies are hot, when new workers and high income households dominate the market, and when housing production is lags well behind demand for most household income levels.[7] Prices on housing rise in the short term. Low and moderate income consumers must respond to a shortage of units affordable and available to them. The affordability/availability gap, as shown in Figure 3 and Figure 7, is postulated to be especially acute for low and moderate income households, although it may exist for all

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[5] Kain, John F., "A Contribution to the Urban Transportation Debate: an Econometric Model of Urban Residential and Travel Behavior", November 1962. A classic.
Kain, John F., "The Journey-to-Work as a Determinant of Residential Location", December 1961.
For a more recent analysis which includes a good bibliography, see:
Anas, Alex and Liang Shyong Duann, "Dynamic Forecasting of Travel Demand, Residential Location and Land Development, Papers of the Regional Science Association, Vol. 56, 1985, pp. 37-58.

[6] Quigley, ibid

[7] Inman, Bradley, "Traffic cure is housing where jobs are", San Francisco Examiner, Sunday, December 4, 1988

incomes.

As prices rise for the housing bundle, the commute response of consumers is to seek housing farther out for the lower price contribution of residential location.

> Housing prices decline at a decreasing rate with distance from the central employment location. Households living close to the employment center face high housing prices but low commuting costs. Households farther away face lower housing prices but higher commuting costs.[8]

Lower income consumers may be more willing to commute than upper incomes. The cost of commuting is often assumed to be the wage rate. The wage rate is the time-value of commuting. This simplification can be questioned, but it generally works.

However, the commute response to higher prices is not the only response. Consumers have preferences for many housing services besides reduced commute time. If the price elasticity of locational choice is the same as the price elasticity of all other attributes, and all prices on housing rise together, then consumers chooses to live farther out. Income differences in elasticities show a different, unexpected result. Smith, Rosen and Fallis report:

> In more complicated models, households have the same tastes but different incomes. If the disutility of commuting is proportional to the wage rate and the demand for housing services is not too inelastic, high-income households will live farther from the central employment location than low income households.[9]

Other sources derive similar conclusions. Straszheim said succinctly:

> The travel-time equation exhibits statistically significant elasticities with respect to both the level of prices and incomes. Richer households are more disposed to commute long distances in the face of any given rent surface than poorer households, implying that the savings in expenditures associated with richer households' much higher levels of consumption outweighs the disutility of a longer commuting trip.[10]

A salient fact in these observations is that higher income consumers invariably can out-bid lower income consumers for the same bundle of products. Higher incomes exhibit a

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[8] Smith, et al., ibid, p. 38.

[9] Smith, et al., ibid, p. 38. This quote refers to a book by Muth, Richard J., Cities and Housing, Chicago: University of Chicago Press, 1969.

[10] Strassheim, Mahlon R., An Econometric Analysis of the Urban Housing Market, National Bureau of Economic Research, New York: New York, 1975, p. 102.

greater willingness to pay for the same housing.

Because there is a shortage of housing, and because lower incomes are outbid by higher incomes, the lower incomes must find other means of coping with high housing prices. The coping responses include:

- overcrowding,
- finding more roommates,
- keeping adolescents in the nest longer,
- out-migration from the region,
- rent transfers (late payments, non-payment, rent control),
- decreased maintenance,
- fewer structural amenities such as garages, floor space or bathrooms.
- paying more of income for rent and less for other goods.

No hedonic pricing studies were found which comprehensively show the price elasticities for these coping responses to exogenous price rises. If such studies are developed, it would be helpful if they also controlled for responses at different household income levels.

Proposals to increase housing availability must consider jointly the utility preferences of income categories, filtering, coping mechanisms and demographic data. Lower income households are probably already slightly closer to their work, and their work may not all be located in central areas either. The size of lots and units are most likely smaller for lower incomes. There are fewer added amenities and structural qualities. Household sizes, and number of commuters per household is also be different by income, but this study does not predict the type of difference.

This study does not develop policy measures to affect household incomes, although it recommends sensitivity to incomes. Policies which support housing production for lower incomes cheapen the rent, but they may not be effective in reducing the longer commute distances of higher incomes. The affordability/availability gap however often indicates that the shortfall in housing production is primarily in the lower and moderate income households. Filtering down is not adequately bringing the market to equilibrium, and filtering up is cutting further into availability for lower and moderate incomes. Therefore it is tentatively concluded that policy measures should directly address the zoning needs, land use concerns and housing production/subsidy needs for lower and moderate income households if so indicated by the J/H range.

One of the microeconomic warnings to policy makers is that higher income consumers have a voracious appetite for quality housing and choice locations. They willingly out-bid the lower incomes and drive them from the market. This fact suggests that the denser zoning, mixed use developments, smaller lots and units, and environmental and social problems which accompany many subsidized housing developments are in fact

the only effective barrier to the buying power of higher income households. Inordinate consumer surplus should be avoided in construction and pricing of affordable housing for the lower incomes.[11]

A.4. LOGIT AND PROBIT MODELS OF RESIDENTIAL CHOICE: NEW HOPE

A more promising, difficult and expensive avenue of modelling is the use of probit or logit models. These models accept the premises of hedonic, "bid-rent" pricing, but seek to better define the decision making process in locational choice.

Ken Train[12] and Kenneth Sobel[13] used the technique called the "nested logit model", so called because of the recursive placement of natural logarithms in the logarithms of variable coefficients. The work by Train used the theory to estimate sequential choice of mode to work and car ownership.

Jung-Chuel Shin reports that most of the expected results of hedonic pricing are found using the nested logit data purification methods. There is hope for applying this method further because of its good results in eliminating error. Shin says:

> Despite relatively small sample size, the use of a nested logit model produces statistically significant parameter estimate (sic) largely because of explicit treatment of the full range of trade offs a household may make. Previous decision models, in which some aspects of the process are assumed to be fixed, do not make full use of the available information in the estimation process...[14]

Any simplification of the technique, reduction of costs and lessening of sample size which the logit model offers is welcome. The spatial complexity of the urban markets make measurement of the marginal propensity tc commute extremely difficult.

Studies by Alex Anas[15] and Ken Train[16] summarize the growth of probabilistic

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[11] This policy warning applies to existing rental housing as well. Rent controls which put a "cap" on capital improvements and operating and maintenance pass-throughs are implicitly limits on accruing surplus value to units. Luxury improvements eventually will surface in rent increases or in pressures to evict. Alternatively, allowable capital improvements can be related to the health and safety of the tenants, not to cosmetic improvements which lead to rent raises and displacement.

[12] Train, Ken, "A Structured Logit Model of Auto Ownership and Mode Choice," Review of Economic Studies, Vol. XLVII(2), 1980.

[13] Sobel, Kenneth L., "Travel Demand Forecasting by Using the Nested Multinomial Logit Model," Transportation Research Record 775, National Academy of Sciences, 1980

[14] Shin, Jung-Chuel, Residential Location Choice, Stanford University PhD thesis, 1985 (?), p. 5.

[15] Anas, Alex, Residential Location Markets and Urban Transportation: Economic Theory, Econometrics, and Policy Analysis with Discrete Choice Models, Academic Press, New York, 1982, pp. 17-48.

[16] Train, Ken, Qualitative Choice Analysis: Theory, Econometrics, and an Application to Automobile Demand, MIT Press, Cambridge, Massachusetts, 1986.

choice models, also called the "probit" model.

Shin reports the conclusion that:

> It is feasible and sensible to represent households' mobility decisions within a sequential decision framework, consisting of residential location, housing type, car ownership, and mode to work decisions.[17]

Shin best describes the probability choice theory in these words:

> A probabilistic choice theory provides an alternative to the bid rent approach. As discussed in the previous section, bid rent theory is concerned with determining how much of each of a number of commodities a given household will select. However, some households' decisions are better characterized by addressing the question of which of a number of available options a household will select. In other words, the relevant household decision process does not focus on 'how much' of each commodity to consume, but 'which one' to select. This choice theory perspective eliminates some of the essential problems inherent in the traditional bid rent theory. Households rarely make their housing decisions based on the amount of land on which they wish to reside. Rather, size of lot is an attribute of the location decision bundle they select. Households ultimately select one and only one option. Thus, although the bid rent approach, because of its analytic simplicity , can provide important behavioral insights, the location decision process is actually better described by probabilistic choice theory.[18]

Through the logit and probit models, better estimation of the housing selection processes could some day lead to more predictable and measurable indicators of the J/HB.

A.5. CERVERO'S PUSH-PULL GRAVITY MODEL

The push-pull gravity model of transportation modal choices has been applied to the jobs/housing balance. The model hereafter is called the "Cervero model."[19]

The Cervero model is based on development of a dependent interaction variable which tells the volume of commuting level between large population census tracts. The model is applied to the Bay Area's four largest suburban employment clusters. Data is collected on journey-to-work, place of residence, and place of work. Data is also collected for variables of mode of transportation, average travel time, housing costs, availability, occupational breakdowns (two income categories), socio-economic characteristics, sex, and land-use zoning near residences and work. A simple jobs/housing ratio in the area of work

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[17] Shin, op. cit., p.4

[18] Shin, ibid., pp. 24-25.

[19] Cervero, Robert, Jobs-Housing Imbalances as a Transportation Problem, Institute of Transportation Studies, U.C. Berkeley, UCB-ITS-RR-86-9, Sept. 1986.

is included as a variable.

A new numerical model expression is created for each of the four suburban employment clusters. Each expression yielded different significant variables and a different R^2. This creates a serious problem of model specification, since each cluster is defined by a new equation. Factors that did not make the cut as significant variables are assumed away as either insignificant or as not measurable. This multiple model specification implies that there is not a single larger regional model into which the suburban cluster is situated. It seems to imply that each suburban job cluster has a separate job market and distinct housing consumer preferences.

The Cervero model has a low explanatory ability. The best fitting equation is that for all clusters combined with an R^2 of .307.[20] Other causal factors of commuting and residential location behavior are therefore not explained in the model.

The Cervero model offers hints of policy areas to be examined. The sex difference in commuting time for "professionals", the contribution of number of vehicles per household and the residential zoning variable are possible areas of study.

It may be possible to compare the best-fit equations for different suburban clusters and the aggregate to settle upon a likely, well-specified equation for the region. Even then, its applicability across time, and to other regions would be doubtful. One of the permanent sources of error in the Cervero model is that journey-to-work data is poor because it is based on commute times measured from central points of census tracts. The commute time is affected strongly by access to transit, freeways and thoroughfares, and it is strongly affected by location with the census tract.

The variables on housing costs and residential zoning are also garbled sources of error. Housing costs (once more) are not prices on a unitary good, but consist of summations of relevant hedonic preferences. Residential zoning, or the lack of exclusionary zoning, is also subjective in measurement and therefore a chronic source of error.

In general, however, the Cervero model is an interesting experiment which yields some clues on the many variables which affect residential location decisions.

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[20] The F statistic for the equation for all clusters combined is 278.7, p=.001 and n=2633. The large sample size seems to contribute to a good equation mathematically, but unbelievable in terms of explanation.

A.6. THE ABAG APPROACH TO MEASURING J/HB

The Association of Bay Area Governments (ABAG) developed a methodology for measuring part of the affordability/availability gap.[21] ABAG's work approached but did not reach the development of the J/HB range. It includes the full range of incomes and attempts to demonstrate their affordability index. It does not measure the supply of available units on the market. Nor does this model measure the marginal customers and housing on the market, it only measures the total population disaggregated by income.

Two sub-regions are measured: the interstate 680 and the Interstate 580 corridors modelled by the Metropolitan Transportation Commission. Income levels per household are predicted by:

- o surveys of the total projected number of jobs in the corridor;
- o assignation of SIC industrial sectors &/or occupational categories for each new development; incomes are assigned to occupational categories;
- o workers-per-household estimates for each income level.

Housing supply is proxied by looking at the income level per household and comparing that to the HUD determinations of poverty or need levels. The end result is a matrix showing ten levels of income and the numbers of workers and households at each level in the transportation corridor.

The portion of the J/HB which is indicated by this method is the affordability curve. The ABAG result is promising, but to be ultimately useful it should include data on actual housing prices for the marginal house on the market -- the availability curve. It should also measure incomes for housing seekers, not for all households. This kind of data is best found by extensive surveying, and through cooperation of real estate research bureaus. The ABAG approach uses readily available data from Projections 1987, the Census, HUD income categories, and national labor and business statistics. Actual home sales data on new and resale homes and surveyed rent data can approximate the housing supply shown by the availability line.

In any case, extensive surveying of housing supply would be much more accurate -- and expensive. Only surveying could reveal hedonic preferences and likely substitutability of attribute preferences. Without knowing substitutability and the price elasticity of location choice the appropriate levels of government subsidy for housing or income growth cannot be determined.

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[21] Association of Bay Area Governments, Jobs/Housing Balance for Traffic Mitigation, Nov. 1985

APPENDIX B

WHICH AREAS SHOULD APPLY J/HB BASED MEASURES?

B.1. LAND USE CONTROL MEASURES

This appendix introduces "land use control measures." It describes the limited extent to which EPA and the states utilize land use controls. Secondary source reviews, coastal policies, and housing planning and general plan requirements are among the few state interventions.

The Clean Air Act as amended August 1977 requires states to create State Implementation Plans (SIPs) for achieving air quality goals. In California the SIP is an aggregation of the regional plans put together by regional Air Pollution Control Districts (APCDs) and regional planning agencies.

The State Air Resources Board approves or rejects the local plans and submits those plan elements necessary for compliance with the Clean Air Act and associated federal regulations. EPA reviews, advises on, and approves or disapproves the Regional Air Quality Management Plans (or parts thereof) and the SIP. If the State or region cannot provide an adequate SIP, EPA must step in and write its own Federal Implementation Plan (FIP).

The Clean Air Act requires that SIPs contain transportation control measures (TCMs) to reduce negative impacts of automobile emissions on air quality. TCMs must meet EPA approval to be included by rule in the SIP. Currently few TCMs are official rules. The 1977 amendments to the Clean Air Act require reasonably available control measures.

Transportation control measures which use land use and zoning controls or incentives are more properly called "land use control measures". Policies which use indicators of the balance (or imbalance) of jobs and housing are called "jobs/housing based land use control measures" in this report.

In general, land use controls reallocate property rights -- rights to develop, trade and use property. Land use controls are almost exclusively within the power of local governments, except for clear areas of eminent domain by state and federal agencies.

- **Federal Land Use Controls**

  Although the 1970 amendments to the Clean Air Act allowed land use measures as possible means of air quality management, the specifics were never clear. EPA has generally avoided directly applying land use measures to control transportation. EPA usually defers land use decisions to local municipalities and counties. Indirect sources such as shopping centers or stadiums, which generate pollutants from users, are not within the rights of EPA to control directly under the 1977 amendments to the Clean Air Act.[22] Federal facilities however can be directly controlled. Most direct land use control authority was removed from the 1977 amendments.

  EPA has two alternative means of land use control which are not usually applied to air quality non-attainment: the National Environmental Protection Act (NEPA) requirements for Environmental Impact Study (EIS) review and the Water Quality Act controls on new wastewater discharge and water hook-ups. Section 316(b)(2) in the Clean Air Act (1977) allows the EPA Administrator to hold up construction grants if the wastewater treatment works contributes directly or indirectly to excessive emissions not accounted for in the SIP plan. A suitable indicator of jobs/housing balance could be applied by EPA officials in EIS reviews and in permit reviews for wastewater discharge and water hook-ups.

  Furthermore, Section 176 of the Clean Air Act provides for review of licensing, permits, and activities by agencies of the Federal Government for conformity with SIPs. This is a potentially strong provision, often called the "conformity requirements".

- **State Land Use Controls**

  The State of California also is reluctant to exercise land use or zoning controls which pre-empt local control. A notable exception is the California Coastal Commission. The Coastal Commission controls land uses within 1000 feet of coastal waters. It has an intricate relationship with local governments which still leaves much to the action or inaction of the jurisdiction.

  The State also regulates permitting of significant projects through the California Environmental Quality Act (CEQA). CEQA, like NEPA, is a powerful tool. Lead agencies and responsible agencies review a variety of environmental factors which result from land uses. Special provisions make it difficult for agencies to reject permits for housing development.

- **Regional Intervention**

  California's state law requires community General Plans and regional fair-share housing needs assessments. General (or "master") plans include transportation (or "circulation") elements, housing (or "residential") elements, and land use elements. As an option they may include an air quality element. The elements are supposed to be consistent with each other, with projections on housing need, and with local ordinances such as zoning laws. Often, however, the general plans include vague statements of principles and fail to address cumulative impacts and structural problems. The placement of housing, workplaces and transportation infrastructure in relation to each other rarely are observed for cumulative impacts on automobile circulation.

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22 For background see: Melnick, R. Shep, Regulations and the Courts: The Case of the Clean Air Act, The Brookings Institution, Washington, D.C., 1983 & Hagevick, George et al., Air Quality Management and Land Use Planning: Legal, Administrative and Methodological Perspectives, Praiger Publishers, NY, NY, 1974.

Periodically the regional planning agency, or council of governments, is required to review housing needs in the region and allocate in a fair-share each jurisdiction's goals for housing. Transportation and air quality impacts of the assignment of goals are not examined during the "housing needs assessment" process. This is ironic in that the COG is usually also a major contributor to transportation and air quality planning for other studies. In fact, federal highway funds are a mainstay for the budget of regional planning agencies.

The Clean Air Act and state governments generally take a regional approach to implementing clean air goals. This is in contrast with local control over land use and zoning. The cumulative impacts of local controls on a region is not dealt with directly by regional, state or federal agencies. Studies of the jobs/housing balance instrument require a regional conceptualization of the transportation problems caused by local decisions or inaction. The next section provides background on such studies.

B.2. COSTS AND BENEFITS OF LAND USE CONTROL MEASURES

An economic analysis of J/HB based land use control measures can assist in deciding on where to apply them. This section reviews cost/benefit principles as they apply to such measures. The principles are ideals. Rarely can an agency gather all the data on costs and benefits. Instead, programs which are approved should be cost effective, i.e. the most benefits for the least cost.

Local and regional governments should spend on a control measure until the marginal cost of the control measure equals the marginal cost of alternative air quality improvement measures. For instance, APCDs should add incrementally to current housing subsidies until the point where other control measures with similar benefits are of equal or less cost.

The cost of effective zoning and housing strategies is expected to rise exponentially. There are increasing marginal costs for removing each additional emission which contributes to air quality non-attainment. A societal cost-benefit analysis would count non-air quality costs, such as the cost of job loss in the auto industry or the benefit of reduced time-cost of commutes. The marginal benefits of J/HB based policies decrease slowly -- there is plenty of room for societal gain from reducing commute distances.

Spending on any control measure should continue until the marginal cost for the measure is equal to the marginal benefits of decreasing air pollution. For example, the monetary loss in down-zoning to maintain open space should continue until society is no longer willing to pay the increasing marginal cost for cleaner air and external benefits. Exceeding that point results in societal "dead-weight loss" or unnecessary loss in productivity.

The APCD should make chosen strategies cost effective. The APCD should analyze the measures to provide the most benefits for the least cost. "Least cost" should ideally include both least cost to the agencies involved and least cost to private industry and society at large.

The entire Land Use Control Measure menu of land use, zoning, housing supply, job siting and trip reduction needs to be examined in the spirit of finding the least cost and most beneficial control.

APCDs can often find measures at the least marginal cost by redirecting current governmental and private activities to become more sensitive to air quality improvement. Many governmental programs related to job development and housing provision are already in operation. Jobs/housing balance measures which redirect or enhance these programs offer effectiveness at a lower cost. The concern is with **marginal costs** and **marginal benefits**, so the costs that are **incrementally added on** to existing programs are the salient expenses.

Since EPA and state laws usually set performance standards for air quality attainment, the hard job is to select the proper package of least cost control strategies. If land use control measures are going to be used, then those strategies should be cost-effective, in order to reduce the costs of the total package. The following section discusses the applicability and acceptability of such measures.

B.3. J/HB BASED MEASURES AND NON-ATTAINMENT AREAS

Jobs/housing balance based policies might be included in SIPs or state mandated regional air quality management plans to reduce mobile source emissions. J/HB policies are a long range control which can be emphasized in rapidly expanding non-attainment areas which have exhausted many of the quicker and simpler measures. In effect, these policies may provide needed reductions in emissions when other measures are already being applied and if alternative measures are too costly. In addition, J/HB based measures can help any rapidly growing area maintain the air quality standards in areas which are in compliance.

Older, non-expanding non-attainment areas such as Chicago may not benefit greatly from J/HB based policies.

The stringency of application should vary depending on the magnitude of an area's non-attainment. The states want to continue the tradition of staying out of local land use policy as much as possible, so as not to "infringe", but also to leave it up to local governments and industry to reduce costs.

J/HB measures are more acceptable locally if they are linked with other area needs and likely benefits. For example, regional transportation planners are very aware of the need for greater density of housing development to support mass transportation. Bus lines

need enough customers on a short enough route to economically support their service. J/HB policies can help achieve the densities needed for regional transportation planning of alternatives to automobile commutes.

A better balance of jobs and housing will have positive effects other than on air quality. The automobile commuter contribution to congestion would be reduced. Marginally less money would be spent on road construction and highway costs. Demand for gasoline would be less. City or sub-regional jobs or housing shortages would be lessened for lower income households and minorities -- therefore achieving greater social equity and true housing or economic opportunity. All of these externalities to air quality J/HB policies could lead most non-attainment areas to seek out such policies.

Regions and states would benefit the most if the policies are developed at the time of jobs, housing or traffic project approval. It is always more difficult to retrofit development plans, because of economic commitment to one form of development and not another. Transportation planning, for example, should include land use policies that balance potential jobs and housing sites at the onset, along with transportation control measures.

In summary, most states and regions should consider J/HB based policies, but non-attainment areas will most likely resort to such measures first. The time is ripe, as shown by the interest generated by the South Coast's recent plans. Regions will find significant other benefits to improving the jobs/housing balance. The policies will be most effective if implemented at the beginning of development, and more difficult as a planning or infrastructure retrofit.

APPENDIX C:

BIBLIOGRAPHY OF LAND USE CONTROL MEASURE STUDIES

Association of Bay Area Governments,
Jobs/Housing Balance for Traffic Mitigation, published by the Center for Analysis and Information Services at ABAG, Oakland, California, November 1985.

Association of Bay Area Governments,
Air Quality Planning in the Bay Area: 1987 Update, published by ABAG for the Bay Area Air Quality Management District and MTC, Oct. 1987.

Cambridge Systematics,
Improved Air Quality in Maricopa and Pima Counties -- the Applicability of Transportation Measures, Prepared for EPA, Reg. IX, November 1986.

Cervero, Robert,
"Congestion, Growth and Public Choices", Berkeley Planning Journal.

Cervero, Robert,
Jobs-Housing Imbalances as a Transportation Problem, Institute of Transportation Studies, U.C. Berkeley, UCB-ITS-RR-86-9, Sept. 1986.

Deakin, Elizabeth,
"Traffic mitigation in the Development Process: Experiences, Impacts and Issues", Institute of Transportation Studies, U.C. Berkeley, UCB-ITS, WP-85-12, August 1985.

Deakin, Elizabeth,
"Land Use and Transportation Planning in Response to Congestion Problems: A Review and Critique", paper for the ACSP 29th Annual Conference, Los Angeles, CA, November 5-8 1987.

Deakin, Elizabeth,
"Transportation and Land Use Planning in California: Problems and Opportunities for Improved Performance", paper prepared for the Assembly Office of Research, State of California, January 1988.

Institute for the Future,
Jobs/Housing Relationship: Mission Bay, San Francisco, prepared for and published by San Francisco Department of City Planning.

Kreines, Susan,
Expanding the Jobs/Housing Discussion: Examples of EIR Sections and Staff Reports, Kreines and Kreines a California Corporation, Tiburon, California, 1989.

Newman, Peter W. G. and Jeffrey R. Kenworthy
"Gasoline Consumption and Cities: A Comparison of U.S, Cities with a Global Survey", APA Journal, Winter 1989, pp. 24-37.

Planning and Community Development Dept.,
Sacramento County General Plan: Policy Plan, Sacramento, California, July 1982.

Planning and Community Development Dept., County of Sacramento,

"Planning for a Jobs and Housing Balance: Industrial Development Strategy Study, Second Phase Report", by Robert C. Burness and J.Richard Blackmarr, August 1982.

Pucher, John,
"Urban Travel Behavior as the Outcome of Public Policy: The Example of Modal-Split in Western Europe and North America", APA Journal, Autumn 1988, pp. 509-520.

Southern California Association of Governments,
Preliminary Draft of Series II: Paper A: A Menu of Strategies for Achieving Job/Housing Balance, Dec. 4, 1987.

Southern California Association of Governments,
SCAG Job-Housing Survey, August 1988, prepared by Gregory John Sater. This is a review of SCAG survey responses on jobs-housing balance policies of various California cities and counties.

Southern California Association of Governments,
Appendix IV-1 Growth Management Plan, 1988 Revision, from the Air Quality Management Plan, October 1988.